AECOM

Lower Passaic River Restoration Project

2012 Periodic Bathymetry and Single Beam Surveys Report

December 2014

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Cooperating Parties Group

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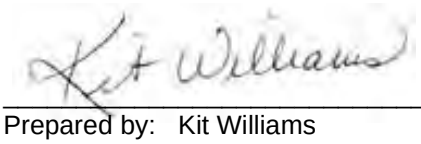
Lower Passaic River Restoration Project

2012 Periodic Bathymetry and Single Beam Surveys Report



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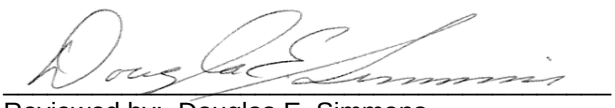

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1.0 Overview

The 2012 Periodic Bathymetry and Single Beam Surveys (2012 Periodic Surveys) were performed under the specifications of the United States Environmental Protection Agency (USEPA)-approved Quality Assurance Project Plan (QAPP) for Lower Passaic River Restoration Project: Periodic Bathymetric Surveys, Revision 2 (AECOM, 2010) as modified by two field modifications: 1) Field Modification Number FM-120821-1 for the performance of a periodic bathymetry survey of the lower 14 miles of the Passaic River after a period of below average river flows; and 2) Field Modification Number FM-120830-1 for performance of a single beam survey in shallow areas located outside the limits of the multibeam bathymetry surveys. The 2012 Periodic Surveys are the fifth in a series of periodic multibeam bathymetry surveys (which include a single beam component) performed by the Cooperating Parties Group (CPG) as part of the Lower Passaic River (LPR) Remedial Investigation (RI) and Feasibility Study (FS). Gahagan & Bryant Associates, Inc. (GBA) previously conducted four similar surveys in 2007, 2008, 2010, and 2011 over the same extent of the Lower Passaic River Study Area (LPRSA) and one survey in the River Mile (RM) 10.9 Study Area in the summer of 2011. Single beam surveys, which covered the majority of the areas surveyed in 2012, were previously performed in 2007 and 2011. The previous surveys are documented in the following reports:

1. Single Beam Hydrographic Survey of Passaic River: River Mile 0.5 to 8.2 and Wallington Avenue Bridge to Upstream Limit (GBA, 2007a);
2. Passaic River Multibeam Hydrographic Survey: River Mile 0 to 14.3 (GBA, 2007b);
3. Passaic River Multibeam Hydrographic Survey Newark, New Jersey December 2008 (GBA, 2009);
4. Periodic Bathymetry Survey Report: June 2010 Multibeam Survey (GBA, 2011a);
5. Bathymetry Survey Report for Lower Passaic River RM 10.9 Characterization, July 2011 (GBA, 2011b); and
6. Fall 2011 Post Hurricane Irene Bathymetry Survey Report (GBA, 2012).

The 2012 Periodic Surveys were conducted by AECOM's contractor, GBA between August 29, 2012 and September 29, 2012. The 2012 Periodic Surveys consisted of both multibeam and single beam components and was performed between August 29, 2012 and September 17, 2012. The 2012 Single Beam Survey was performed between September 12, 2012 and September 29, 2012. The 2012 Periodic Surveys (Figure 1) were conducted in the RM 0 to 14 area of the LPRSA. The 2012 single beam survey was conducted of nine areas with shallow water depths, less than -6 feet National Geodetic Vertical Datum of 1929 (NGVD29) (less than 6 feet deep), outside the limits of the multibeam surveys (Figure 2 and Figure 3). AECOM performed oversight on behalf of the CPG during the 2012 Periodic Surveys and reviewed the GBA report submittals. Sea Engineering, Inc. provided oversight on behalf of the USEPA.

The 2012 Periodic Surveys were performed by the CPG to characterize the potential effects of an extended period of below average river flows. The extended period of low river flows during 2012 provides a potential opportunity to evaluate the ongoing sediment infilling that occurs during low flow periods. The 2012 LPR flows were below the typical winter and spring high flow events. During periods of 2012 the flow was up to one order of magnitude below the period of record average flow. A comparison of bathymetric data before (October 2011) and during the period of extended low flows (August 2012) provides a potential opportunity to characterize upriver estuarine transport of sediments that has been observed historically in the LPRSA. Given the short time frame between surveys (less

than one year), and the error and uncertainty inherent in bathymetric data and low rates of infilling, the data may only be sufficient to provide a qualitative or semi-quantitative evaluation of net changes over large areas, and may not support evaluation of local changes.

The 2012 Single Beam Bathymetry Survey was performed in nine shallow areas located outside the limits of the periodic multibeam surveys. The 2012 Multibeam Survey was limited to areas with depths greater than approximately -6 feet NGVD29, due to beam limitations and risk of damage to the multibeam transducer head. The 2012 single beam surveys were designed to fill in the shallow river areas, typically below the -6 feet NGVD29 contour (water less than 6 feet deep) . Previously, in 2007, single beam surveys were performed by the CPG in five of the areas and part of a sixth area surveyed in 2012. In two of the remaining three 2012 survey areas, the RM 10.9 Removal Area and the mouth of Third River, a single beam survey was performed by the CPG in 2011. The CPG has not previously performed single beam surveys in the remaining 2012 survey area (RM 9.6 – 10.2). The 2012 single beam transects replicate the previous single beam transects where available to the extent possible.

All work was performed per the QAPP (as modified by Field Modifications FM-120821-1 and FM-120830-1), contract requirements, United States Army Corps of Engineers (USACE) specifications, and acceptable industry standards. The precision and accuracy of the data collected were consistent with the USACE manual, Engineering and Design - Hydrographic Surveying (EM 1110-2-1003; USACE, 2002). The raw and processed data have been reviewed to ensure that the requirements of the USEPA-approved QAPP have been met. The data collected during these surveys meet the data quality objectives to address the above study questions, with consideration to the uncertainty inherent in these data and described in the QAPP.

No interpretations of the survey results are included in this report and its attachments. Data analyses and interpretation of this survey as well as its relationship to other surveys will be conducted as part of the LPRSA Conceptual Site Model (CSM) development, sediment stability analyses, Lower Passaic River/Newark Bay Modeling Program, and other components of the LPRSA RI/FS.

The following documents are attached:

1. Periodic Bathymetry Survey 2012 Report, Lower Passaic River, New Jersey, prepared by GBA;
2. Single Beam Bathymetry Survey 2012 Report, Lower Passaic River, New Jersey, prepared by GBA; and
3. Periodic Bathymetry Survey and Single Beam Survey, 2012 Oversight Report, Lower Passaic River, New Jersey, prepared by AECOM.

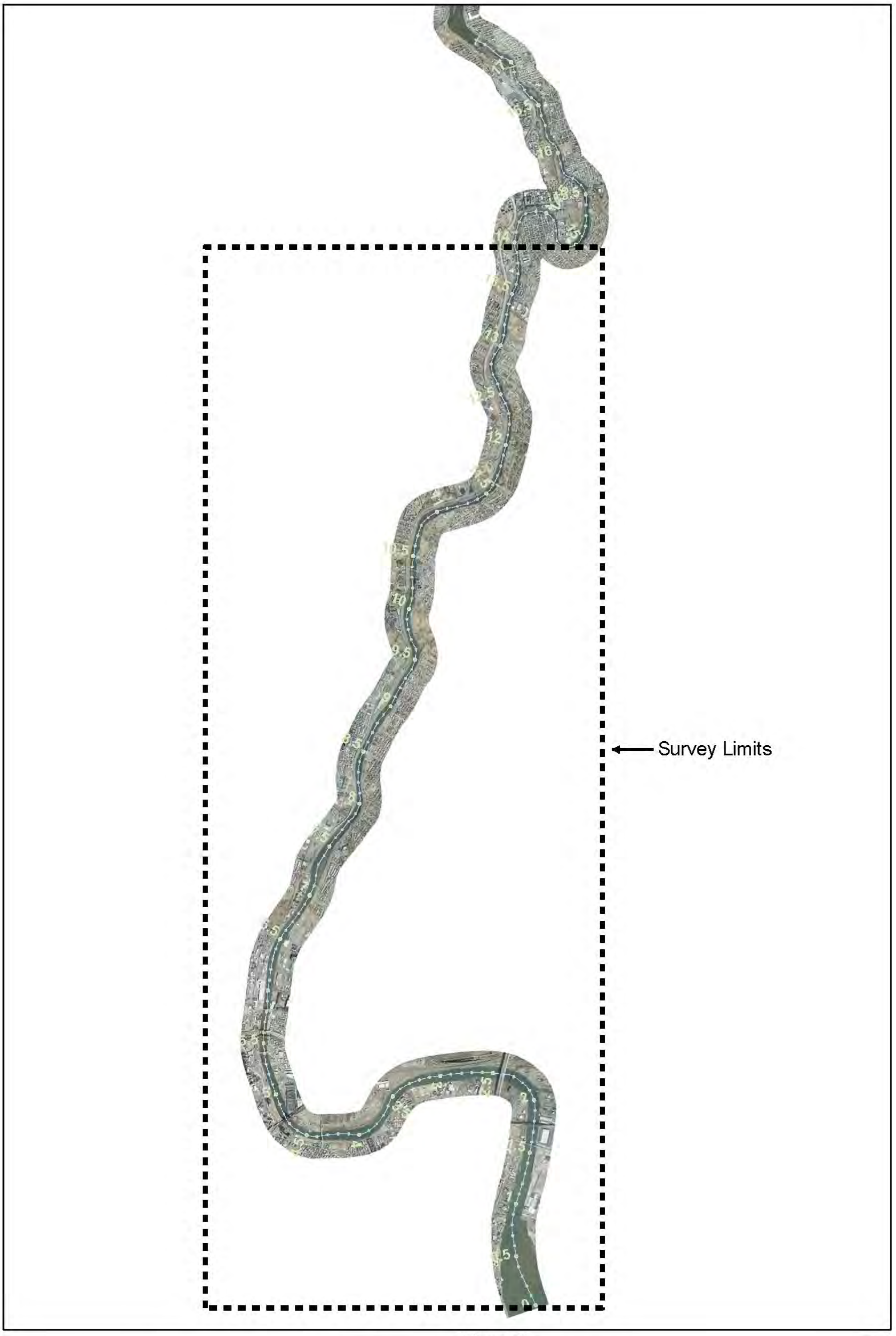

Figure 1
Periodic Bathymetric Survey
Lower Passaic River Restoration Project
Multi-beam Survey Limits

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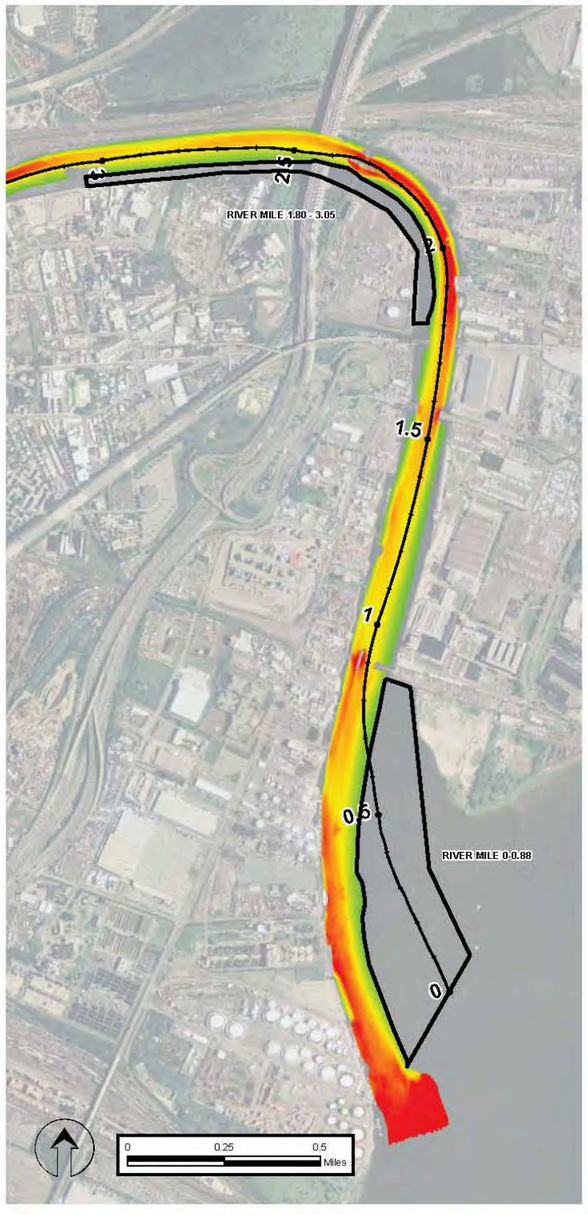
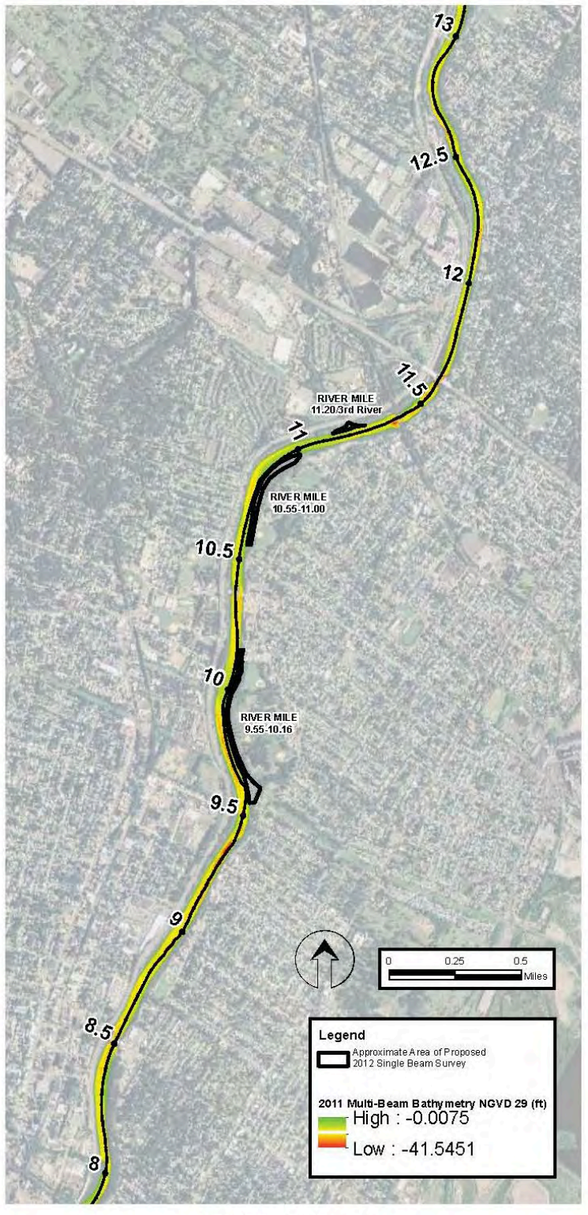
Figure 2 Locations for Single Beam Bathymetry Survey



RIVER MILE 0-3

RIVER MILE 3-8



RIVER MILE 8-13

2.0 References

AECOM, 2010. Quality Assurance Project Plan, Lower Passaic River Restoration Project: Periodic Bathymetric Surveys, Revision 2, May.

AECOM, 2012a. Field Modification Number FM-120821-1 for the Performance of a Periodic Bathymetry Survey of Lower 14 Miles of the Passaic River after a Period of Below Average River Flows. August 21.

AECOM, 2012b. Field Modification Number FM-120830-1 for Performance of a Single Beam Survey in Shallow Areas Located Outside the Limits of the Multibeam Bathymetry Surveys. August 30.

Gahagan & Bryant Associates (GBA), 2007a. Single Beam Hydrographic Survey of Passaic River: River Mile 0.5 to 8.2 and Wallington Avenue Bridge to Upstream Limit. August 2007. November.

GBA, 2007b. Passaic River Multibeam Hydrographic Survey: River Mile 0 to 14.3.

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GBA, 2012. Fall 2011 Post Hurricane Irene Bathymetry Survey Report. March.

United States Army Corps of Engineers (USACE), 2002. Engineering and Design Manual - Hydrographic Surveying. EM 1110-2-1003. Washington, D.C. Last accessed in November 2012 at: http://140.194.76.129/publications/eng-manuals/em1110-2-1003/toc.htm.

Attachment 1

Periodic Bathymetry Survey, 2012 Report, Lower Passaic River, New Jersey prepared by GBA

PERIODIC BATHYMETRY SURVEY, 2012 REPORT

Lower Passaic River

New Jersey

Submitted:
October 2012
Revised:
December 2014

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APPENDICES

1.0 INTRODUCTION

Gahagan & Bryant Associates, Inc. (GBA) has performed five previous bathymetry surveys of the Passaic River, New Jersey between September 2007 and October 2011. Four encompassed the lower 14 river miles (RMs) and one was focused on the River RM 10.9 area. The Periodic Bathymetry Survey, 2012 was conducted of the lower 14 RMs of the Passaic River for comparison with previous bathymetry surveys to support characterization of changes, if any, which may have occurred over the past year after the 2012 extended period of below average river flows. In addition, consistent with previous periodic bathymetry surveys in 2008, 2010, and 2011, a single beam survey was conducted for 13 selected transects. These surveys were performed with the same methodologies as all previous surveys. Additional single beam survey data was collected by a second vessel on nine shallow areas located between RM 0.0 and 11.3. The results from that survey operation are reported under a separate cover in the Single Beam Bathymetry Survey, 2012 Report (GBA, 2012).

The GBA survey team departed for the Passaic River on August 28, 2012. Multibeam patch testing and quality assurance/quality control (QA/QC) testing were initiated on August 30, 2012. Survey lines were established based upon channel coordinates to best obtain 100% bottom coverage. The bathymetry surveys commenced on August 30, 2012 and concluded on September 17, 2012. The purpose of this report is to summarize the operations and quality controls employed during the survey and subsequent data processing. Control information is provided in Appendix 1. Results from the survey are presented in Appendices 2 and 3. Appendix 4 contains the field notes and Appendix 5 (provided electronically) includes supporting data such as the AutoCAD drawings, HYPACK files, and ASCII data.

2.0 SURVEY SETUP AND CONTROL

On August 29, 2012, GBA survey technicians recovered various control points along both sides of the Passaic River that had been used during previous surveys. Reference points were recovered and their horizontal and vertical coordinates were measured using a Leica SmartGPS GX1230+ rover/receiver with a CDMA cellular phone modem. Real Time Kinematic (RTK) corrections were obtained via the CDMA modem from a permanent CORS (Continuously Operating Reference System) site located at the New Jersey Institute of Technology (NJIT) in Newark, NJ. See Appendix 1 for specifics on the NJIT site and Station Description for NJI2, which is the National Geodetic Survey (NGS) control point utilized for the NJIT CORS site.

All points were checked against either published values listed in the NGS database, or against values determined by GBA using static RTK methods during the 2010 Passaic River survey. Table 1 summarizes the published or measured coordinates for each reference monument. The horizontal projection for this survey is North American Datum 1983 (NAD 83) New Jersey State Plane (Zone 2900).

Table 1 – Primary Control Reference Monuments

NAME	SOURCE	NORTHING	EASTING	ELEVATION (NAVD88)	DESCRIPTION
01392590 A	NGS	692097.663	588059.003	11.670’	AI7796 Steel Rod
G101	NGS	715490.263	592312.818	14.240’	KV3414 Disk
PORT 1	GBA 2010	695188.398	597847.469	8.961’	Sheared Metal Bolt
PATH	GBA 2010	701845.995	585643.039	5.705’	PSE&G Disk "PRO4"
NUTLEY 2	GBA 2010	720714.538	592028.699	7.952’	TPS NEAR NUTLEY
CPG2	GBA 2010	733825.441	597109.293	7.936’	TPS NEAR CPG

From the primary control points listed in Table 1, tide staffs were established via closed level runs to points directly at the water’s edge. Reference marks to determine water surface elevation with tide staffs were set at PATH 3, NUTLEY, and the Cooperating Parties Group (CPG) dock (Table 2). These were used to provide daily QA/QC checks of the accuracy of the RTK Global Positioning System(s) derived water surface elevations during the survey. An additional tide staff was set at PORT 2. The elevations of the tide staff reference marks are provided in Table 2. In order to maintain consistency with historical survey datasets from the Lower Passaic River, Quality Assurance Project Plan (QAPP) *Lower Passaic River Restoration Project: Periodic Bathymetric Surveys, Revision 2* (AECOM 2010), all final soundings reference the National Geodetic Vertical Datum of 1929 (NGVD29). The NGS VERTCON program was utilized in adjusting the North American Vertical Datum of 1988 (NAVD88) vertical values to NGVD29 datum.

Table 2 – Tide Staff Vertical Information and description

STAFF	ELEVATION (NAVD88)	ELEVATION (NGVD29)	DESCRIPTION
PORT 2	8.89’	10.01’	Mark on southeast corner of concrete
PATH 3	6.11’	7.19’	Triangle cut on concrete wall on east side of river
NUTLEY	8.54’	9.60’	Mark on concrete wall on west side of river
CPG	8.18’	9.19’	Triangle cut on top of steel bulkhead

3.0 BATHYMETRY SURVEY

All work conducted during the bathymetry survey was performed in accordance with the QAPP (as modified by Field Modification Number FM-120821-1 for the performance of a periodic bathymetry survey of the lower 14 miles of the Passaic River after a period of below average river flows), contract requirements, USACE specifications, and acceptable industry standards. The following represent minor deviations from the QAPP and the field modification.

1. Ongoing construction at the Lister Avenue Site blocked full coverage up to the -6-foot NGVD29 contour and/or to the bulkhead for 500± feet.

2. Ongoing construction on the Newark side of B06 downriver from the Jackson Street Bridge blocked full coverage up to the -6-foot NGVD29 contour due to a boom that has been put in place. The area impacted extends from RM 4.15 to the Jackson St. Bridge (RM 4.37).
3. There were minor areas along the shore where full coverage up to the -6-foot NGVD29 contour could not be achieved because of trees overhanging the river, and obstructions along the shoreline.

Multibeam Survey

The multibeam portion of this survey extended from the mouth of the Passaic River at RM 0.0 to RM 14.0, which is the upper limit of effective multibeam coverage. The multibeam survey covered the main channel prism and all depths greater than -6 feet NGVD29, residing within the confines of the riverbanks. GBA's survey maintained a buffer of approximately 75 feet around all bridges and in-water structures, as specified in the QAPP. GBA planned and conducted the survey lines and data collection to ensure 100% bottom coverage and to clearly define contours at 0.5-foot intervals.

GBA used the multibeam survey data collected within the confines of the primary 90 degree cone (nadir to 45 degrees both port and starboard) for the processing of final survey results and deliverables. The 90 degree beam angle was selected based upon criteria outlined within the USACE's *Engineering and Design Manual - Hydrographic Surveying, EM 1110-2-1003* (USACE 2002) and GBA's experience in the multibeam environment. Beams residing within the confines of the 90 degree beam angle utilize amplitude detection, which is preferred to phase detection in the outer beams. However, only data within 45 degrees of nadir were used for deliverables.

GBA met the requirements outlined within the USACE's *Engineering and Design Manual - Hydrographic Surveying, EM 1110-2-1003* (USACE 2002) as augmented by April 1, 2004 updates to Chapter 11 for multibeam surveying. GBA met standards for multibeam surveys conducted for Navigation and Dredging Support Surveys in soft bottom materials.

Single Beam Survey

GBA also conducted a single beam survey of 13 selected transects as surveyed during the fall 2008, spring 2010, and fall 2011 survey events. These transects extended from RM 1.6 to RM 8.0 and met all requirements outlined within the USACE's *Engineering and Design Manual - Hydrographic Surveying, EM 1110-2-1003* (USACE 2002).

Survey Equipment

GBA utilized equipment analogous to the equipment used on the 2007, 2008, 2010, and 2011 surveys. The 2012 survey equipment included the following components:

Multibeam Equipment

1. The multibeam data collection system consisted of a Reson SeaBat 8101 system operating at +/- 240 kilohertz (kHz) with a total beam angle of 210 degrees. Each individual beam angle measures 1.5 degrees by 1.5 degrees. The Seabat 8101 was upgraded to include Reson's backscatter and side scan software options. The Reson's transmitter and receiver (transducer) is permanently mounted on a bow-deployable arm, designed by GBA to best suit the shallow draft requirement of this project and to ensure the stability of the transducer.
2. Primary horizontal and vertical positioning was accomplished by utilizing a Leica SmartGPS GX1230+ rover/receiver with a CDMA cellular phone modem. RTK corrections were obtained via the CDMA modem from a permanent CORS site located at the NJIT in Newark, NJ. See Appendix 1 for specifics on the NJIT site and station description for NJI2, which is the NGS control point utilized for the NJIT CORS site. This method of positioning was chosen in lieu of establishing our own transmitting base stations at numerous control points due to security issues. GBA also utilized the aforementioned positioning methods as it replicated the 2007 through 2011 surveys. The NJIT CORS Station and the Leica SmartGPS GX1230+ were used for all horizontal and vertical positioning and included water surface elevations. These procedures have been used on all past surveys.
3. GBA utilized the most recent version of HYPACK/HYSWEEP® 2012 for data collection and editing which collects and processes all data on high speed PC-based data collection platforms.
4. Inertially-aided positioning was provided by an Applanix – TSS POSMV.
5. Heave/pitch/roll/yaw compensation was accomplished with the Applanix – TSS POSMV.
6. The method for determining water surface elevations (tide levels) was the same methodology used on all previous surveys. Analog tide staffs, used as QA/QC for the RTK, were set at the same tidal gauging locations used for the 2007 through 2011 surveys. Real time tides were obtained by using the global position system (GPS) in the RTK mode, and these RTK elevations were checked and verified against the analog tide staffs numerous times during the course of a survey day to ensure the accuracy required, as specified in the QAPP, was met or exceeded.
7. The survey vessel *Sea Fix*, a 25-foot aluminum hulled vessel constructed by Thomas Marine in 1997, was used for the multibeam and single beam survey work. It was powered by twin 135 horsepower (HP) outboard motors with an onboard power generating system to operate the survey equipment. The vessel captain was the same on all four multibeam surveys and Ed DeAngelo has served as the Technical Project Manager and Lead Field Surveyor on all multibeam surveys conducted on the project as well as the single beam surveys in 2008, 2010, and 2011.

Single Beam Equipment

1. GBA utilized an Odom Mark II operating at 200/33 kHz (+/- 10%) with a 3.5 degree beam angle transducer.

2. The GPS positioning equipment was the same as for multibeam positioning which included a Leica SmartGPS GX1230+ receiver with a CDMA cellular phone modem.

3. GBA used HYPACK 2012 and a high speed PC for data collection. GBA used its proprietary in house processing software, ODP, as well as HYPACK 2012 for editing.

4. Water surface/tide elevations were obtained using RTK GPS and were verified with tide staffs as in the multibeam survey.

5. The survey vessel, *Sea Fix*, was used to conduct the single beam surveys as well as multibeam. Refer to item 7 under multibeam equipment for more details.

4.0 DATA PROCESSING

The survey target was 100% bottom coverage. This target was achieved. In addition and where possible, in the deeper areas of the river, GBA made all efforts to ensure that the multibeam data collected provided 100% overlap. This was the case the majority of the time. Shallow water depths were the limiting factor on some of the survey lines, and 100% overlap was not possible in the shallower depths, as referenced in GBA's initial proposal and subsequent conversations with AECOM staff during prior surveys.

The initial processing of the multibeam data was performed on site to ensure accuracy and that sufficient coverage had been achieved. The multibeam data was then transferred to GBA's Houston Office for final processing and QA/QC verification.

Multibeam data were processed using the HYPACK, Inc. HYSWEEP® utility in three phases. Offsets to account for the position of the Reson SeaBat 8101 sonar head and attitude were applied both in the field and during Phase I of the HYSWEEP® utility. Offsets were determined from physical measurements and multibeam patch tests performed in the field. RTK tides were reviewed and a 30-second average was applied in this phase as well. Sound velocity casts that were collected throughout the survey day were graphed and cleaned of any spikes or erroneous data. These casts were applied to the survey data in Phase I of HYSWEEP®.

In Phase II of HYSWEEP® multibeam processing, beam angles were limited to 45 degrees port and starboard per project requirements, and additional minimal filters were applied to account for overhang and undercut topography as well as the quality of the sounding. After filtering, manual editing occurred. Care was taken to not over clean,

and minimal statistical filters (deviation of 2 sigma above and below the bin average depth in overlapping passes, accounting for sloping bottoms) were applied. During Phase III of HYSWEEP®. Overlapping swaths were reviewed and compared for coverage, depth repeatability, accuracy, and gaps. Final XYZ files of the multibeam data were created using HYSWEEP® and the HYPACK Mapper utility. The data was binned into 3x3 and 1x1 matrices and the average elevation with the actual XY coordinate for each cell was exported. All XYZ data points, XYI (X, Y, and Intensity) files for creating tracking plots, and 1x1 and 3x3 matrix files were also exported.

Cross sections of the single beam check lines were exported from ODP, and Trimble Terramodel was used to produce contours at 0.5-foot intervals; final survey drawings were produced in AutoCAD.

Back scatter and sidescan sonar data from the Reson Seabat 8101 were collected in 2012 as had been done for the four previous surveys conducted by GBA in 2007, 2008, 2010, and 2011. Back scatter imagery can be processed into side scan type imagery, as needed, to assess current or future conditions of the river bed.

Single beam survey data were processed in a manner similar to the multibeam dataset using HYPACK and GBA's proprietary ODP editing software. Raw data files were opened and the parameters for the application of ancillary data (motion, tide, speed of sound, etc.) were defined. At this stage the tide values that are applied to each raw file can be reviewed and erroneous RTK spikes removed (as under bridges). Final single beam data points were then exported to ASCII XYZ files and compared to multibeam sounding data using Terramodel and ODP.

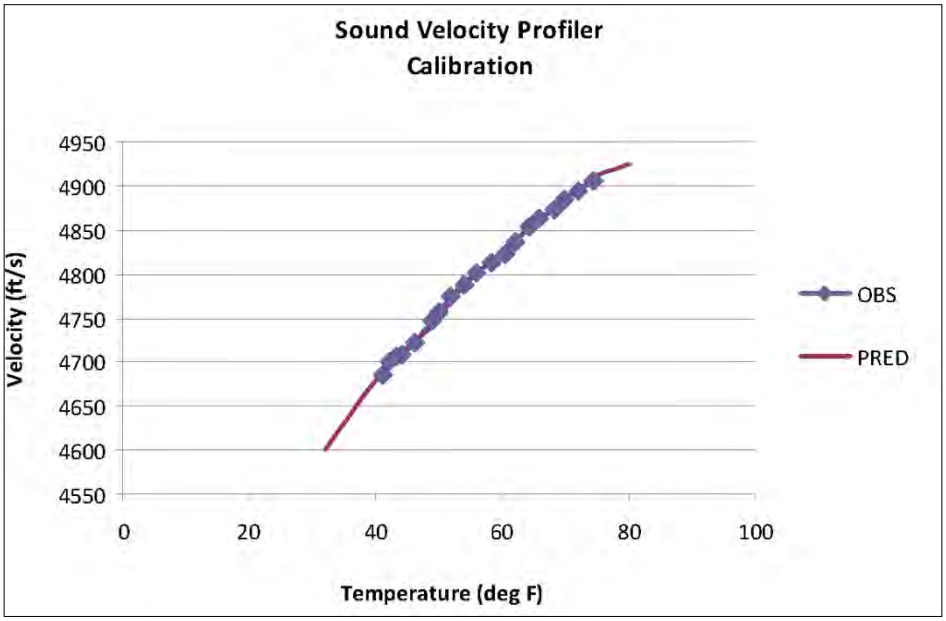
5.0 QUALITY ASSURANCE /QUALITY CONTROL

Throughout the 2012 survey GBA performed several QA/QC procedures. Some QA/QC checks were performed prior to mobilization and included physically verifying all horizontal and vertical offsets for positioning and sounding equipment, performing a complete systems operation check in Baltimore, and verifying the sound velocity profiler calibration. Periodic QA/QC checks included the patch and performance tests that were completed at the beginning, middle, and end of the survey. Daily QA/QC procedures included twice daily position checks, three times daily vertical checks, multiple sound velocity casts and bar-checks for single beam operations, and single beam check lines at approximately 500 foot intervals perpendicular to the channel. This section details the methods employed to provide quality assurance for the survey data.

Sound Velocity Profiles

The sound velocity profiler calibration was verified as per the method prescribed in the USACE's *Engineering and Design Manual - Hydrographic Surveying, EM 1110-2-1003* (USACE 2002). The profiler was set in a distilled-water bath using ice to vary the water temperature. Observed sound velocity measurements and water temperature were recorded and plotted against a predicted curve as shown in Figure 1.

Figure 1 - Sound Velocity Profiler Calibration



Throughout each survey day, GBA surveyors performed several velocity casts and applied them to the multibeam data to ensure that tidal variation did not significantly affect the sounding data.

RTK Corrections

To ensure the accuracy and precision of the Leica SmartNet RTK corrections that were received from the NJIT CORS station, GBA (using a backpack rover) made RTK point observations at both NGS monuments and GBA control points. All checks were within tolerances for RTK GPS of +/- 0.05 feet.

Daily checks of the RTK position system were performed by logging the vessel position at the dock at the beginning and end of each day to ensure no horizontal changes. RTK tides were checked three times (the beginning, middle, and end of each day) by comparing the computed RTK tides to analog tide readings at NUTLEY and/or the CPG dock. All RTK tides checks agreed with analog readings within tolerances for RTK GPS of +/- 0.1 ft.

Patch Tests

Patch tests were used to determine and correct system bias for latency, pitch, roll, and yaw. These tests were performed on three occasions during the course of the 2012 survey as follows:

1. August 30, 2012 – Initiation of the survey (Pre-Survey)
2. September 11, 2012 – Midway during the survey (Mid-Survey)
3. September 17, 2012 – Completion of the survey (Post-Survey)

Similar to the Fall 2011 Post Hurricane Irene Survey, all patch tests were performed in Upper Newark Bay where there was sufficient water depth in the maintained channels

for the roll bias test, and sufficient bottom elevation change/slope to perform the pitch, yaw, and latency tests. Two additional roll tests were performed on September 9 and September 16 immediately following a minor strike of the multibeam sonar head on submerged pilings near the shoreline. The strike occurred along the Newark shoreline at approximately RM 7.25.

Because the values for each bias are completely dependent on hardware installation, and will vary from vessel to vessel, there are no standards. However, the USACE does recommend that the roll bias be measured to the nearest tenth of a degree (0.1), and pitch and yaw be measured to the nearest degree. Results from the patch tests are provided in Table 3.

Table 3 - Patch Test Results Summary

Date	Roll (Degrees)	Pitch (Degrees)	Latency (Seconds)	Yaw (Degrees)
August 30, 2012	-1.90	2.70	0	-0.80
September 9, 2012	-1.90	not performed	0	not performed
September 11, 2012	-1.90	2.70	0	-0.80
September 16, 2012	-1.70	not performed	0	not performed
September 17, 2012	-1.65	2.70	0	-0.80

Figures 2 through 4 show the results from the HYPACK analysis for each bias variable for the pre-survey, mid-survey, and post-survey tests.

Figure 2 - Results from the *August 30, 2012* Pre-Survey Patch Test in Newark Bay

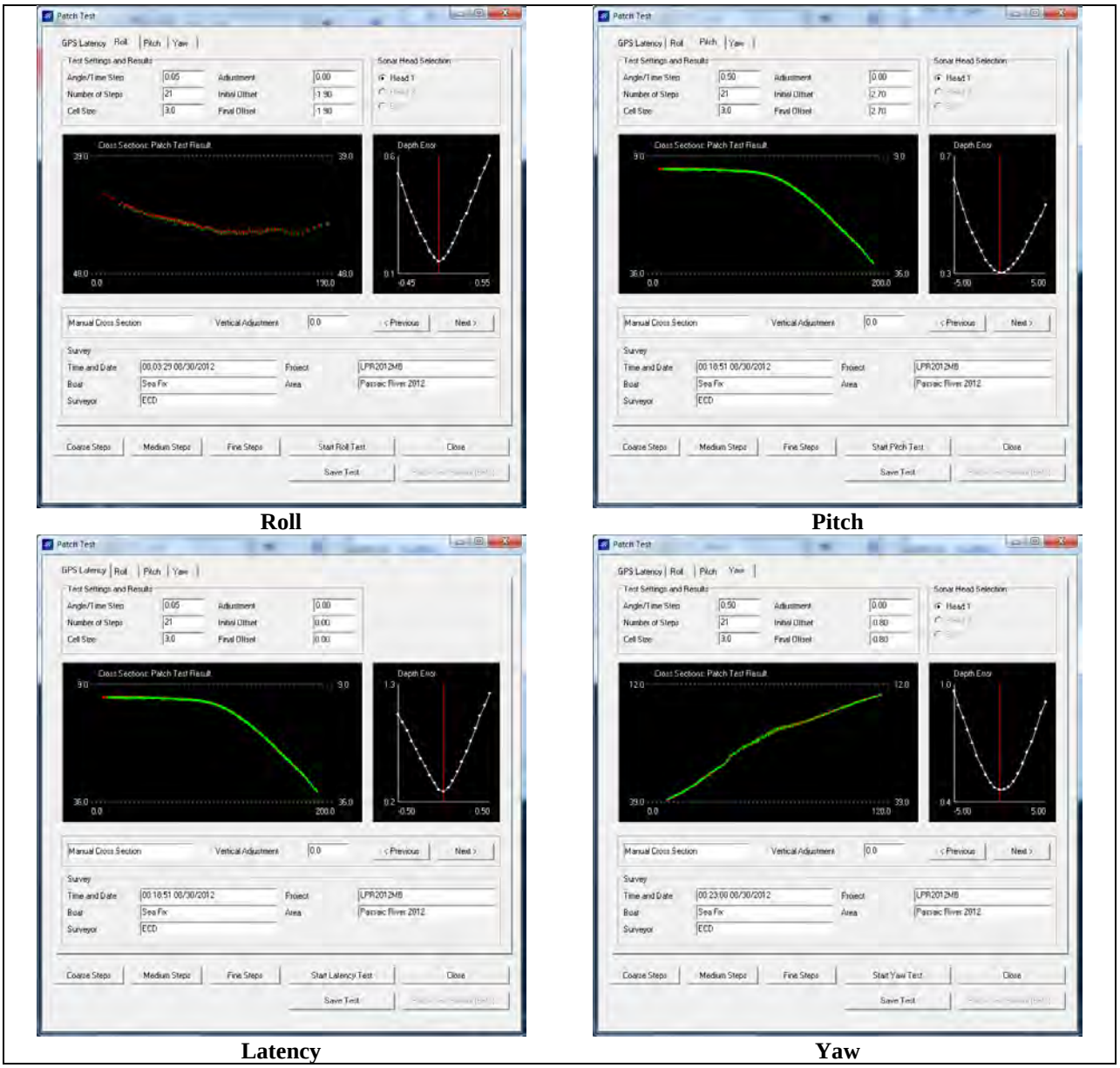
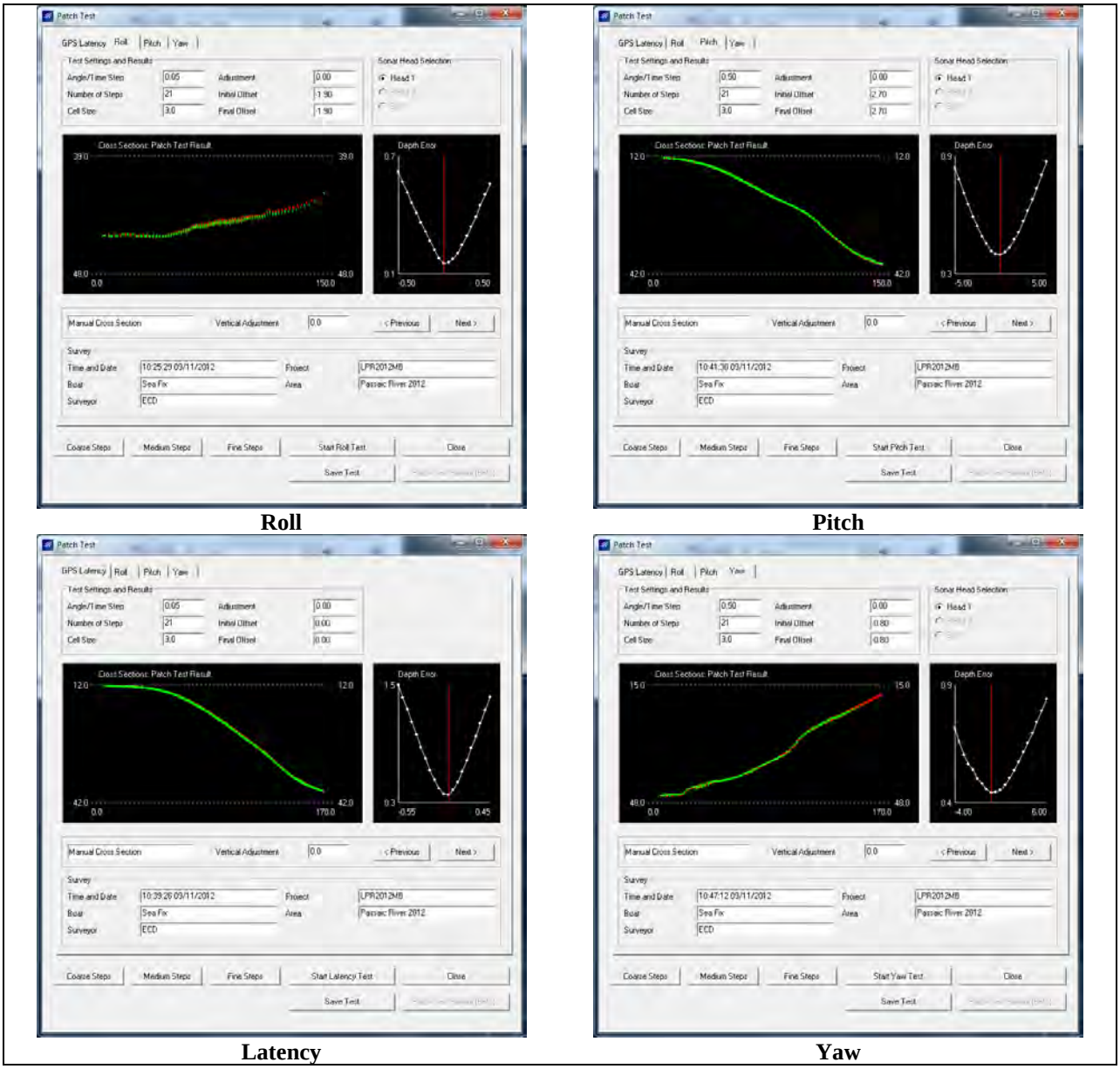


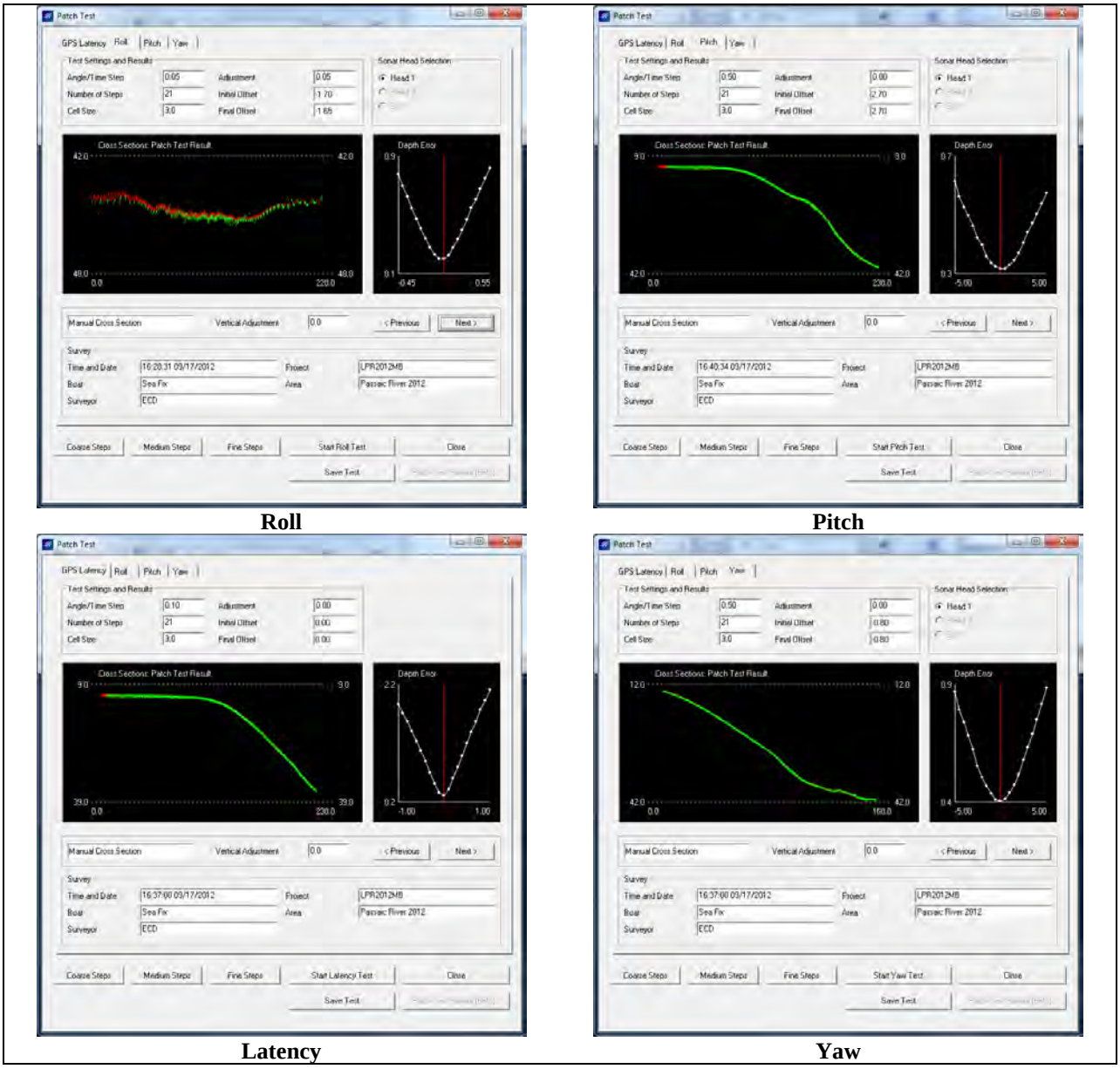
Figure 3 - Results from the *September 11, 2012* Mid-Survey Patch Test in Newark Bay



Roll **Pitch**

Latency **Yaw**

Figure 4 - Results from the *September 17, 2012* Post-Survey Patch Test in Newark Bay



Roll **Pitch**

Latency **Yaw**

Performance Tests

The multibeam performance test consists of two parts: 1) beam angle test and 2) single beam test. The beam angle test compares multibeam check lines to a reference surface and estimates the depth accuracy of the multibeam system at various angle limits. The estimated accuracy can be used to determine if the multibeam system meets survey specifications. Similarly, the single beam test provides a statistical comparison of single beam cross sections to a reference multibeam surface.

The reference surfaces were different for each performance test but were all collected in the same location in Upper Newark Bay. As per the prior surveys of the Lower Passaic River, the same reference surface was used during a given patch and performance test, but varied between patch and performance tests performed during the survey. This practice has been conducted consistently since the 2008 Lower Passaic River survey.

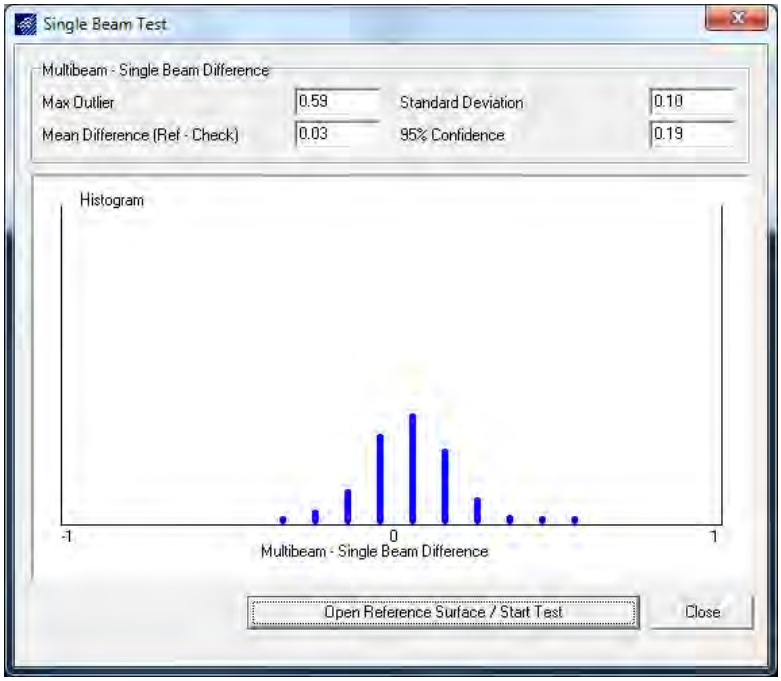
Three performance tests were performed to document the accuracy of the bathymetry survey system. Tests were done concurrent with the Patch Tests noted on pages 9 through 11 and occurred prior to survey operations on August 30, 2012 (Pre-Survey), at approximately the mid-point of the survey on September 11, 2012 (Mid-Survey), and at the completion of the survey on September 17, 2012 (Post-Survey).

The repeatable results of all the performance tests show that the survey system remained stable in its accuracy and precision through the course of the survey operations. The recommended USACE criteria for multibeam performance tests in soft bottom material are: 1) maximum allowable mean bias (mean difference) <0.2 feet; 2) maximum outlier of 1 foot; and 3) a standard deviation at 95% confidence not to exceed +/- 2.0 feet.

Results from the three performance tests are presented below in Figures 5 through 7:

Figure 5 - *August 30, 2012* Pre-Survey Performance Tests

Single Beam-Multibeam Performance Test



Beam Angle

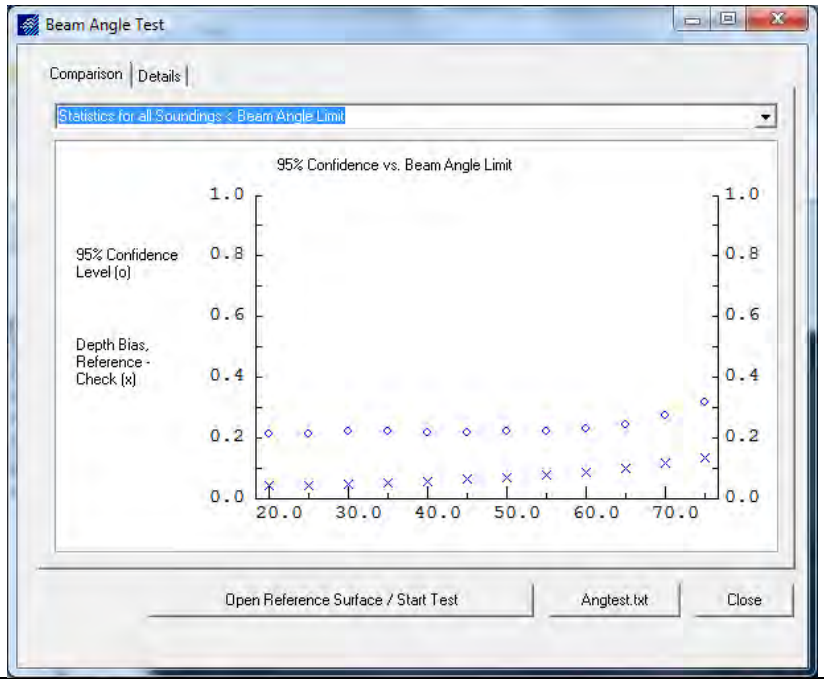
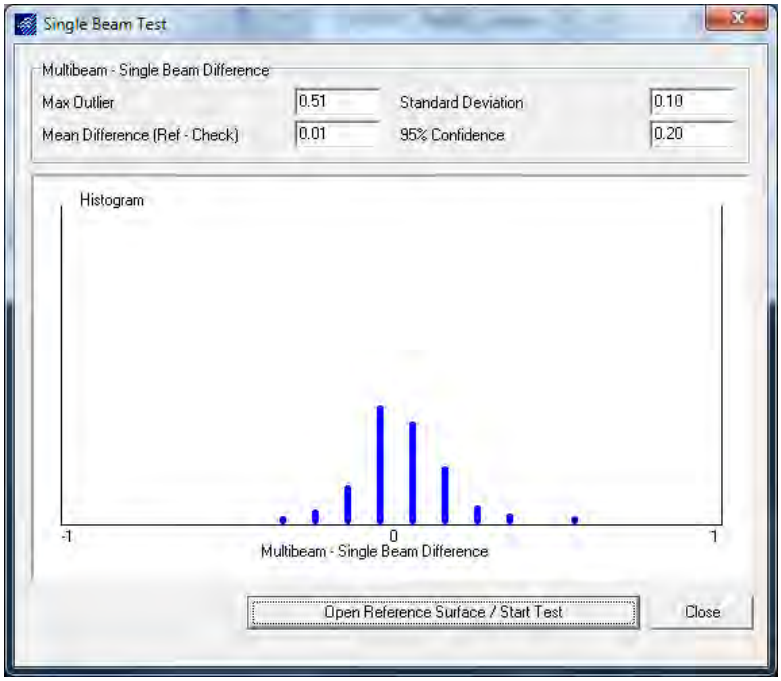


Figure 6 - *September 11, 2012* Mid-Survey Performance Tests

Single Beam-Multibeam Performance Test



Beam Angle

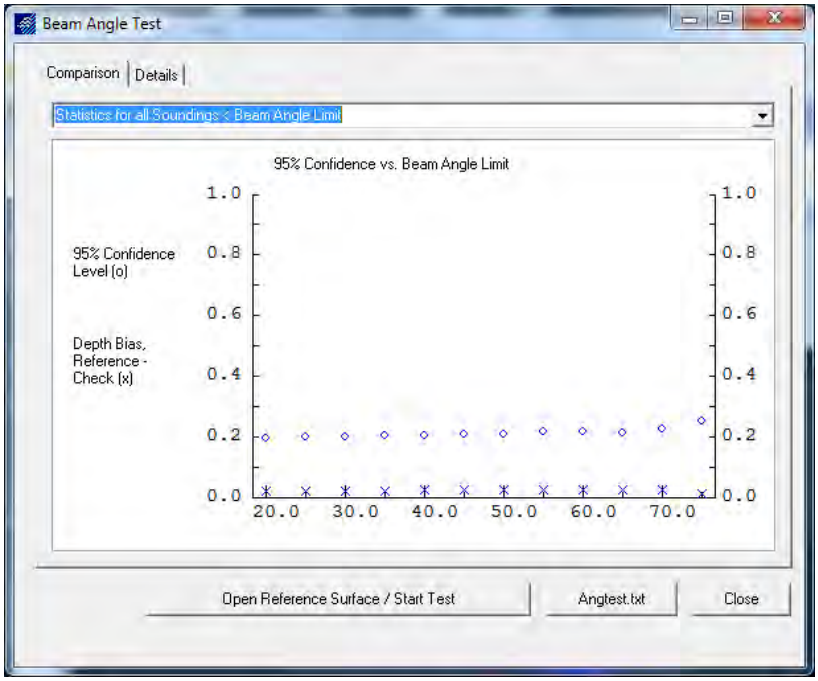
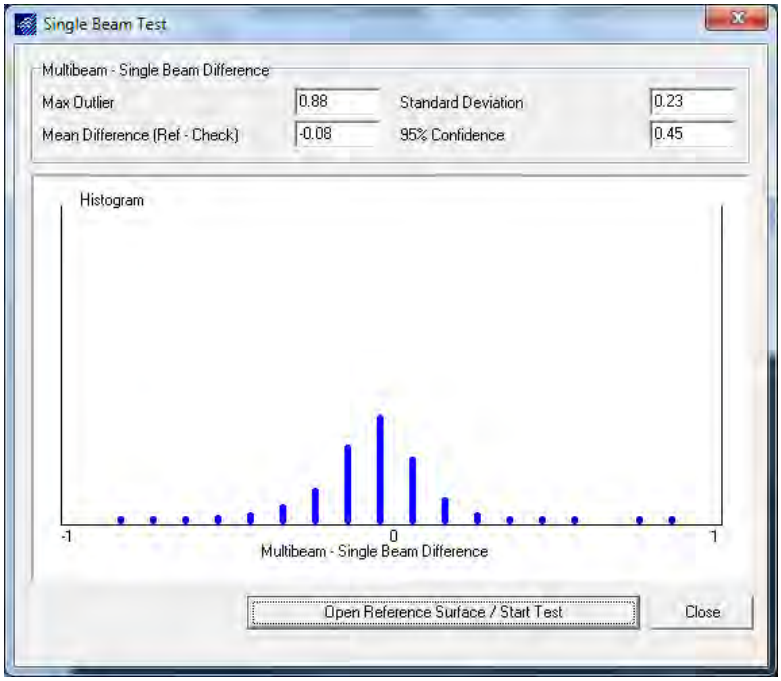
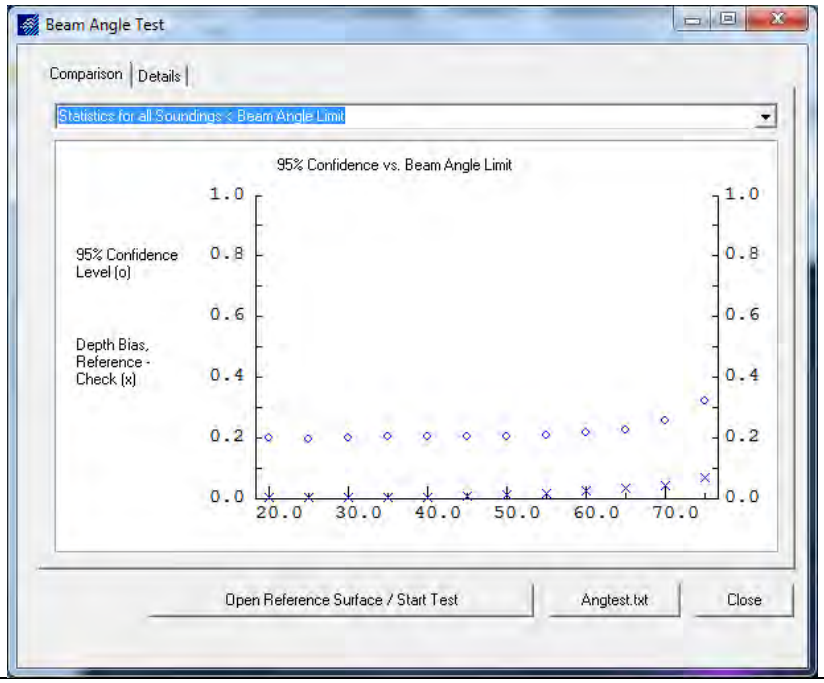


Figure 7 - *September 17, 2012* Post-Survey Performance Tests

Single Beam-Multibeam Performance Test



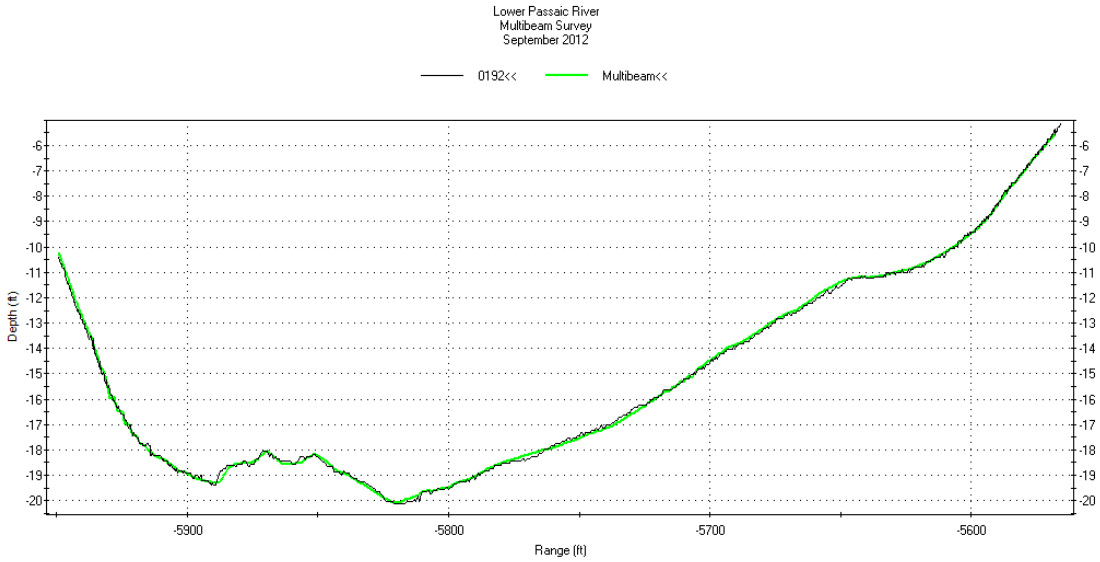
Beam Angle



Single Beam Cross-check Lines

Throughout the course of the survey operations, GBA collected single beam cross sections as checks to compare against multibeam data. Daily cross check lines were spaced at approximately 500-foot intervals and overlain on the multibeam data. Below is a typical cross section showing the consistent agreement between the single beam and multibeam data that does not exceed the recommended minimum of 0.5 feet between the survey technologies, which adds confidence to the fall 2012 multibeam dataset.

Figure 8- Single beam to Multibeam Comparison



Offsite Data Review

All field collected survey data were forwarded to GBA's Houston office on a daily basis. All survey procedures, raw data, and field edited data were reviewed for accuracy and completeness by an independent analyst. Any gaps in the data coverage identified after final data cleaning were forwarded to the field crew for resurvey.

6.0 DAILY OVERVIEW OF SURVEY OPERATIONS

The following information is a summary of GBA's daily surveying activities in reference to the multibeam survey of the Passaic River from RM 0.0 to 14.0:

Tuesday, 28 August, 2012

- Mobilized from Baltimore, MD to Newark, NJ
- Verified configuration for Leica Network RTK

Wednesday, 29 August, 2012

- Checked in to control monuments throughout project site with the RTK Rover
- Checked tide gauges for project site
- Performed trial patch and performance tests for survey equipment

Thursday, 30 August, 2012

- Performed official patch and performance tests for survey equipment (pre-survey tests)
- Surveyed center and edges of Reach B-01 using multibeam
- Surveyed center of Reach B-02 using multibeam
- Performed single beam survey check lines of Reach B-01
- Observers: Jason Magalen (SEA), Bill Gerken (AECOM)

Friday, 31 August, 2012

- Surveyed edges of Reaches B-02 and B-03 using multibeam
- Surveyed center of Reach B-03 using multibeam
- Performed single beam survey check lines of Reaches B-01 and B-02
- Observers: Jason Magalen (Sea Engineering)
- Demobilized to Baltimore for the Labor Day Weekend

Tuesday, 04 September, 2012

- The survey crew and vessel remobilized from Baltimore, MD to Elizabeth, NJ. No survey work was performed this day.

Wednesday, 05 September, 2012

- Surveyed centers and edges of Reaches B-03, B-04, and B-05 using multibeam
- Surveyed center of Reach B-06 using multibeam
- Performed single beam survey check lines of Reaches B-03 through B-06

Thursday, 06 September, 2012

- Crew and vessel completed survey at NYC Passenger Terminals
- Surveyed centers of Reaches B-06, B-07, and B-08 using multibeam
- Surveyed under Jackson St. Bridge using multibeam

Friday, 07 September, 2012

- Surveyed centers and edges of Reaches B-06 through B-09, C-01 and C-02 using multibeam
- Surveyed center and edges of Reach A-08 between Point No Point Railroad Bridge and NJ Turnpike Bridge using multibeam
- Surveyed under NJ Turnpike Bridge using multibeam

Saturday, 08 September, 2012

- Surveyed centers and edges of Reaches A-07 and A-04 using multibeam
- Performed single beam survey check lines of Reaches A-04 through A-08

Sunday, 09 September, 2012

- Surveyed centers and edges of Reaches A-05 and A-06 using multibeam
- Surveyed cleanup edges of reach A-08 using multibeam
- Performed single beam survey check lines of Reaches A-07 through A-03
- Performed roll test on multibeam head after impacting submerged piling
- Surveyed under Pulaski Skyway, Lincoln Highway, and Point No Point Railroad Bridges using multibeam

Monday, 10 September, 2012

- Surveyed centers and edges of Reaches A-01 through A-03 using multibeam
- Filled in small multibeam data gaps at the transition between Reaches A05 and A06
- Performed single beam survey check lines of Reaches A-01 through A-02

Tuesday, 11 September, 2012

- Surveyed centers and edges of Reaches C-03 and C-04 using multibeam
- Performed patch and performance tests for survey equipment (mid-survey tests)
- Surveyed under Bridge St., Newark-Harrison Railroad, and I-280 bridges using multibeam
- Surveyed centers and edges of Reaches D-05, D-06, and D-07 using multibeam
- Crew mobilized to CPG floating dock

Wednesday, 12 September, 2012

- Surveyed centers and edges of Reaches C-04 and D-08 through F-01 using multibeam
- Performed single beam survey check lines Reach D-05 through D-08

Thursday, 13 September, 2012

- Surveyed edges of Reaches F-02 through G-03 using multibeam
- Surveyed centers of Reaches F-02 through H-01 using multibeam
- Surveyed under Conrail Railroad bridge Reach G-03 using multibeam
- Performed single beam survey check lines through G-03

Friday, 14 September, 2012

- Surveyed a small data gap in Reach F04
- Surveyed edges of Reaches H-01, H-02, G-04 using multibeam
- Surveyed centers of Reaches H-02 through H-08 using multibeam
- Performed single beam survey check lines H-01 through H-08

Saturday, 15 September, 2012

- Collected an additional edge line in Reach H03
- Surveyed centers and edges of Reaches H-04 through H-12 using multibeam
- Performed single beam survey check lines H-09 through H-12
- Surveyed under Main Avenue Bridge using multibeam
- Surveyed centers of Reaches D-04 and D-05 using multibeam

Sunday, 16 September, 2012

- Surveyed small gap cleanups in Reaches H06 & H09
- Surveyed centers and edges of Reaches C-10 through D-05 using multibeam
- Interim roll test performed after a minor multibeam head strike on a piling near RM 7.25
- Performed single beam survey check lines C-05 through D-06

Monday, 17 September, 2012

- Surveyed centers and edges of Reaches C-05 through C-09 using multibeam
- Surveyed cleanup data in Reach C11
- Surveyed under old Railroad Bridge and under Conrail Arlington Railroad Bridge using multibeam (Reach D01)
- Performed successful closing patch and performance tests (post-survey tests)

7.0 CONTACT INFORMATION

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Survey Manager:
Douglas Moore email: dcmoore@gba-inc.com

Technical Project Manager:
Edward DeAngelo email: edeangelo@gba-inc.com

8.0 REFERENCES

AECOM. 2010. *Quality Assurance Project Plan, Lower Passaic River Restoration Project: Periodic Bathymetric Surveys, Revision 2.*

AECOM, 2012. *Field Modification Number FM-120821-1 for the Performance or a Periodic Bathymetry Survey of the Lower 14 Miles Of The Passaic River after a Period of Below Average River Flows*. August 21.

Gahagan & Bryant Associates, Inc. 2012. *Single Beam Bathymetry Survey, 2012 Report*. Baltimore, MD.

United States Army Corps of Engineers (USACE). 2002. *Engineering and Design Manual - Hydrographic Surveying. EM 1110-2-1003. Washington, D.C. [augmented April 1, 2004].*

APPENDIX 1

Control Information

01392590 A (AI7796)

NGS PID# AI7796
New Jersey Geodetic Survey (NJGS) Cover – stamped 01392590 1997 (steel rod in casing)
New Jersey State Plane NAD 83 Horizontal Coordinates (feet)
Northing 692,097.663 Easting 588,059.003
Vertical Elevation
NAVD 88 = 11.67’ NGVD29 = 12.78’

Situated in the city of Newark, New Jersey, this control point is a steel rod buried in the ground and encased with a lid as stamped above. The marker is located on the east side of Raymond Avenue at the intersection of Van Buren Street. It is measured 32’ northeasterly from a light pole and 21’ southeasterly from a concrete wall situated on the east side of a concrete walk leading northerly along the exit ramp from Raymond Avenue. Static GPS observations were made from this point to establish horizontal and vertical positioning for the survey project.

CPG

Locally Set Control Point
Triangle carved on top of steel bulkhead
Vertical Elevation (Observed)
NAVD 88 = 8.18’ NGVD29 = 9.19’

Situated in Wallington, New Jersey, this control point is a triangle chiseled into the top of a steel bulkhead along the east side of the Passaic River. The bulkhead is located on the west side of a parking lot for a business center located on the west side of Madison Street. The mark is measured 17.3’ northerly from a light pole and is adjacent to a floating dock. A closed level loop was run from CPG2, situated just north of this point, where static GPS observations were made.

CPG2

Locally Set Control Point
MAG Nail Set
New Jersey State Plane NAD 83 Horizontal Coordinates (feet)
Northing 733825.441 Easting 597109.293
Vertical Elevation (Observed)
NAVD 88 = 7.936' NGVD29 = 8.950'

Situated in Wallington, New Jersey, this control point is a MAG Nail set into asphalt near a steel bulkhead along the east side of the Passaic River. The bulkhead is located on the west side of a parking lot for a business center located on the west side of Madison Street. The mark is measured 8.6' northerly from a light pole and is situated along the west side of a guard rail. Static GPS observations were made at this point and a closed level loop was run to control point CPG situated just south of this location.

G101

NGS PID# KV3414
National Geodetic Survey (NGS) Disk – stamped G 101 1979
New Jersey State Plane NAD 83 Horizontal Coordinates (feet)
Northing 715490.263 Easting 592312.818
Vertical Elevation
NAVD 88 = 14.24’ NGVD29 = 15.29’

Situated in North Arlington, New Jersey, this control monument is located along the southeast side of River Road in the front yard of house #352. It is further located 2.0’ southwest of the southwesternmost side of an asphalt driveway leading to house #354. The mark is measured 6.7’ east of utility pole #A60351 NA and 12.2’ northwest of the guy anchor attached to the pole. Static GPS observations were made from this point to establish horizontal and vertical positioning for the survey project.

NUTLEY

Locally Set Control Point
Mark at edge of Concrete Wall
Vertical Elevation (Observed)
NAVD 88 = 8.54’ NGVD29 = 9.60’

Situated in Nutley, New Jersey, this control point is a mark chiseled on top of a concrete wall along the eastern edge as it abuts the west side of the Passaic River. The concrete wall is situated along the west side of a parking area for a boat ramp. The boat Ramp is located just north of Park Avenue where it connects with the Kingsland Avenue Bridge leading to the east side of the river. A closed level loop was run from NUTLEY2, situated south of this point, where static GPS observations were made.

NUTLEY 2

Locally Set Control Point
Capped Iron Pin Set
New Jersey State Plane NAD 83 Horizontal Coordinates (feet)
Northing 720714.538 Easting 592028.699
Vertical Elevation (Observed)
NAVD 88 = 7.952' NGVD29 = 8.992'

Situated in Nutley, New Jersey, this control point is a capped iron pin set in a gravel parking lot for a boat ramp situated along the west side of the Passaic River. The boat ramp is located just north of Park Avenue where it connects to the Kingsland Avenue Bridge leading to the east side of the river. The point is located 3' westerly from the west edge of a concrete wall along the river and 3' northwesterly of a concrete curb. Static GPS observations were made at this point and a closed level loop was run to control point NUTLEY situated just north of this position.

Path

PSE & G Disk – stamped PRO 4 (Passaic River Outfall #4)
New Jersey State Plane NAD 83 Horizontal Coordinates (feet)
Northing 701845.995 Easting 585643.039
Vertical Elevation (Observed)
NAVD 88 = 5.705’ NGVD29 = 6.791’

Situated in Kearney, New Jersey, this control point is a PSE & G control disk embedded in a concrete flume leading westward from a parking lot into the east side of the Passaic River. The parking lot is situated south of a PathMark grocery store located along the west side of Passaic Avenue. The point is measured 7’ northerly from the south edge of the concrete flume and 3.5’ easterly from a guard rail. Static GPS observations were made here and a closed level loop was run to PATH 3 situated north of this position.

PATH 3

Locally Set Control Point
Triangle cut chiseled on top of concrete bulkhead
Vertical Elevation (Observed)
NAVD 88 = 6.11’ NGVD29 = 7.19’

Situated in Kearney, New Jersey, this control point is a triangle cut chiseled into the top of a concrete bulkhead situated along the east side of the Passaic River. The mark is located to the rear of a PathMark grocery store located on the west side of Passaic Avenue and is measured 35’ northeasterly of a large cleat and 20’ southwesterly of another large cleat. It is further measured 14.5’ northwesterly of the westernmost corner of a storm drain.

PORT 1 & 2

Locally Set Control Point

Sheared Metal Bolt
New Jersey State Plane NAD 83 Horizontal Coordinates (feet)
Northing 695188.398 Easting 597847.469
Vertical Elevation (Observed)
Port 1 NAVD 88 = 8.96' NGVD29 = 10.08'
Port 2 NAVD 88 = 8.89' NGVD29 = 10.01'

Situated near Kearney, New Jersey, this control point is a sheared metal bolt located on a concrete dauphin situated in the Passaic River west of a New York-New Jersey Shipping Authority facility located at the westernmost end of Pennsylvania Avenue. It is measured 6.6' northeast of the southwest side of the dauphin. It is further measured 5.3 feet northwest of the southeast side of the dauphin. Static GPS observations were made here and a closed level loop was run to PORT 2 situated along the southeastern-most edge of the dauphin.

NJIT/NJI2

NJIT

SEARCH NCE GO MY NJIT

NCE
CIVIL AND ENVIRONMENTAL ENGINEERING

Engineers : The Creative Problem-Solvers

About CEE
- Mission
- Program Objectives & Outcomes
- Key Contacts
- Admissions
- Laboratories
- Program Self Study Report

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Research
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News & Events

Surveying GPS Laboratory

Continuously Operating Base Station at NJIT

The GPS base station was established thanks to grants from the New Jersye Society of Professional Land Surveyors and Leica.

IMPORTANT ANNOUNCEMENT:

NGS has renamed the basestation, now that it has a new position. It is now posted as **nji2**.

The following coordinates reflect the relocated basestation, as of June 11, 2001.

SITE:	OPTION:	DATE:
NH Portsmouth , por1	RINEX2 Data	98271 - Sep. 28
NH Portsmouth , por2	Readme.doy	98272 - Sep. 29
NJ Newark , njit	Coordinates (NAD83 & ITRF94)	98273 - Sep. 30
NJ Sandy_Hook , shk1	Coordinates (NAD83 & ITRF96)	98274 - Oct. 1,
NJ Sandy_Hook , shk2	Logfile	98275 - Oct. 2,
NM Pie_Town , pie1	Broadcast Ephemeris	98276 - Oct. 3,

Find_Files | Reset

Latitide: 40 degrees 44' 29.30562" N
Longitude: 74 degrees 10' 39.72764" W

http://civil.njit.edu/about/labs/surveying.php 11/8/2007

The NGS Data Sheet

See file dsdata.txt for more information about the datasheet.

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DATABASE = Sybase ,PROGRAM = datasheet, VERSION = 7.55
1        National Geodetic Survey,   Retrieval Date = NOVEMBER  8, 2007
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 AJ3348  HT_MOD      -  This is a Height Modernization Survey Station.
 AJ3348  CORS        -  This is a GPS Continuously Operating Reference Station.
 AJ3348  DESIGNATION -  NJ INST OF TECH 2 CORS ARP
 AJ3348  CORS_ID     -  NJI2
 AJ3348  PID         -  AJ3348
 AJ3348  STATE/COUNTY-  NJ/ESSEX
 AJ3348  USGS QUAD   -  ELIZABETH (1995)
 AJ3348
 AJ3348                        *CURRENT SURVEY CONTROL
 AJ3348  ______________________________________________________________________
 AJ3348* NAD 83(CORS)-  40 44 29.30573(N)     074 10 39.72731(W)      ADJUSTED
 AJ3348* NAVD 88     -        50.24   (meters)      164.8    (feet)   GPS OBS
 AJ3348  ______________________________________________________________________
 AJ3348  EPOCH DATE  -        2002.00
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 AJ3348  Y           - -4,656,035.856 (meters)                        COMP
 AJ3348  Z           -  4,140,724.998 (meters)                        COMP
 AJ3348  ELLIP HEIGHT-         17.929 (meters)           (03/??/02)  ADJUSTED
 AJ3348  GEOID HEIGHT-        -32.30  (meters)                        GEOID03
 AJ3348  HORZ ORDER  -  SPECIAL (CORS)
 AJ3348  ELLP ORDER  -  SPECIAL (CORS)
 AJ3348
 AJ3348.ITRF positions are available for this station.
 AJ3348.The coordinates were established by GPS observations
 AJ3348.and adjusted by the National Geodetic Survey in March 2002.
 AJ3348.The coordinates are valid at the epoch date displayed above.
 AJ3348.The epoch date for horizontal control is a decimal equivalence
 AJ3348.of Year/Month/Day.
 AJ3348
 AJ3348.The orthometric height was determined by GPS observations and a
 AJ3348.high-resolution geoid model using precise GPS observation and
 AJ3348.processing techniques.
 AJ3348
 AJ3348.The PID for the CORS L1 Phase Center is AJ7974.
 AJ3348
 AJ3348.The XYZ, and position/ellipsoidal ht. are equivalent.
 AJ3348
 AJ3348.The ellipsoidal height was determined by GPS observations
 AJ3348.and is referenced to NAD 83.
 AJ3348
 AJ3348.The geoid height was determined by GEOID03.
 AJ3348
 AJ3348;                  North         East      Units Scale Factor Converg.
 AJ3348;SPC NJ       -   211,890.703   177,219.575   MT  0.99990912   +0 12 37.3
 AJ3348;SPC NJ       -   695,178.08    581,427.89    sFT 0.99990912   +0 12 37.3
 AJ3348
 AJ3348!             -  Elev Factor  x  Scale Factor =   Combined Factor
 AJ3348!SPC NJ       -   0.99999719  x   0.99990912  =   0.99990631
 AJ3348
 AJ3348                           SUPERSEDED SURVEY CONTROL
 AJ3348
 AJ3348  NAD 83(CORS)-  40 44 29.30562(N)     074 10 39.72764(W) AD(1997.00) c
 AJ3348  ELLIP H (06/??/01)   17.928  (m)                        GP(1997.00) c c
 AJ3348
 AJ3348.Superseded values are not recommended for survey control.
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AJ3348.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
AJ3348.See file dsdata.txt to determine how the superseded data were derived.
AJ3348
AJ3348_U.S. NATIONAL GRID SPATIAL ADDRESS: 18TWL6942610384(NAD 83)
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AJ3348
AJ3348                          STATION DESCRIPTION
AJ3348
AJ3348'DESCRIBED BY NATIONAL GEODETIC SURVEY 2002
AJ3348'STATION IS A GPS CORS.  LATEST INFORMATION INCLUDING POSITIONS AND
AJ3348'VELOCITIES ARE AVAILABLE IN THE COORDINATE AND LOG FILES ACCESSIBLE
AJ3348'BY ANONYMOUS FTP OR THE WORLDWIDE WEB.
AJ3348'    FTP CORS.NGS.NOAA.GOV: CORS/COORD  AND  CORS/STATION_LOG
AJ3348'    HTTP://WWW.NGS.NOAA.GOV  UNDER PRODUCTS AND SERVICES.

*** retrieval complete.
Elapsed Time = 00:00:00
```

APPENDIX 2

0.5 ft Contour Plots of Multibeam Data

APPENDIX 3

Single Beam Cross Sections

APPENDIX 4

Copy of Field Notes

APPENDIX 5

Portable Disk including:

Survey Report,
AutoCAD Drawings,
HYPACK Files,
Field Notes,
ASCII Data

Delivered Under Separate Cover

Attachment 2

Single Beam Bathymetry Survey, 2012 Report, Lower Passaic River, New Jersey prepared by GBA

SINGLE BEAM BATHYMETRY SURVEY, 2012 REPORT

Lower Passaic River

New Jersey

Submitted:
October 2012
Revised:
December 2014

Prepared by:

Gahagan & Bryant Associates, Inc.
5803-D Kennett Pike, Centreville Square
Wilmington, Delaware 19807

Prepared for:

250 Apollo Drive
Chelmsford, MA 01824

TABLE OF CONTENTS

1.0 INTRODUCTION

Gahagan & Bryant Associates, Inc. (GBA) has been subcontracted by AECOM since 2007 for hydrographic surveys of the Passaic River, New Jersey including multibeam and single beam surveys. These surveys are conducted to monitor any changes in bathymetry from River Mile (RM) 0.0 to 14.0.

In 2007, GBA conducted a single beam survey of the Lower Passaic River between River Mile (RM) 0.0 to 11.2. From 2008 to 2012, GBA performed four multibeam surveys. Multibeam technology allows GBA to provide 100% coverage for data collection; however, this technology is not suitable for some of the shallow areas found in the Lower Passaic River. For this reason, the multibeam surveys were augmented with single beam data collection in 2011 and again in 2012.

The Single Beam Bathymetry Survey, 2012 was conducted from September 13 to September 29 in collaboration with the Periodic Bathymetry Survey, 2012 (GBA 2012), reported separately. The single beam survey covered nine shallow river areas, typically from -6 feet NGVD29 (less than 6 feet deep), located at:

- RM 0.00 – 0.88
- RM 1.80 – 3.05
- RM 3.50 – 4.32
- RM 6.60 – 7.10
- RM 7.10 – 7.50
- RM 7.50 – 7.80
- RM 9.55 – 10.16
- RM 10.55 – 11.00
- RM 11.20 and Third River.

This report outlines the procedures for conducting the Single Beam Bathymetry Survey, 2012. The resulting bathymetry maps are presented in Appendix 1. Appendix 2 contains the field notes and Appendix 3, provided electronically, includes supporting data such as the AutoCAD drawings, HYPACK files, field notes, and ASCII data.

2.0 SURVEY SETUP AND CONTROL

The horizontal projection for this project is North American Datum 1983 (NAD 83) Jersey State Plane (Zone 2900), and the vertical datum is National Geodetic Vertical Datum of 1929 (NGVD29). Project control replicated previous years and the 2012 Periodic Bathymetry Survey. For survey setup and control information refer to *Periodic Bathymetry Survey, 2012 Report, Lower Passaic River, New Jersey* (GBA 2012), Section 2 and Appendix 1.

The single beam surveys consisted of cross-sectional transects at 50-foot intervals that extended from as close to the shoreline as equipment and safe navigation permitted to the limits of the Periodic Bathymetry Survey, 2012. The cross-sectional transects overlapped the 2011 and 2007 transects for comparison where possible. It should be noted that the 2007 survey transects were on a 100-foot spacing. In addition, the 2007 and 2011 surveys did not cover the same shallow areas.

All attempts were made to survey from –6.0 feet NGVD29, overlapping the multibeam data, to 0 feet NGVD29. Surveys were conducted as close to high tide as possible in order accomplish this goal.

3.0 SINGLE BEAM SURVEY

All work conducted during the bathymetry survey was performed in accordance with the *Quality Assurance Project Plan for Lower Passaic River Restoration Project: Periodic Bathymetric Surveys,* Revision 2 (AECOM 2010), as modified by Field Modification Number FM-120830-1 for performance of a single beam survey in shallow areas located outside the limits of the multibeam bathymetry surveys; contract requirements; *USACE Engineering and Design Manual - Hydrographic Surveying EM 1110-2-1003*, dated January 1, 2002; and the USACE criteria and standards for Navigation and Dredging Support Surveys for Projects with soft bottom material.

Survey Equipment

GBA utilized equipment analogous to the equipment used on the 2007 through 2011 surveys. The Single Beam Bathymetry Survey, 2012, equipment included the following components:

1. GBA utilized an Odom CV 100 depth recorder operating nominally at 200 kHz (+/- 10%)
2. GBA accomplished primary horizontal and vertical positioning was by utilizing a Leica SmartGPS GX1230GG rover/receiver with a CDMA cellular phone modem. Real Time Kinematic (RTK) corrections were obtained via the CDMA modem from a permanent CORS (Continuously Operating Reference System) site located at the New Jersey Institute of Technology (NJIT) in Newark, NJ. This positioning method replicates the previous multibeam surveys. Refer to the *Periodic Bathymetry Survey, 2012 Report Lower Passaic River, New Jersey* (GBA 2012) for more details.
3. GBA utilized HYPACK 2012 and a high speed PC for data collection. GBA used its proprietary, in-house processing software for editing.
4. GBA used the same method for determining water surface elevations (tide levels) as was used on all previous surveys. Analog tide staffs, used as quality assurance/quality control (QA/QC) for the RTK, were set at the same locations used for the 2007 through 2011 surveys. RTK tides were obtained by using GPS in the RTK mode, and these RTK elevations were checked and

verified against the analog tide staffs numerous times during the course of each survey day to ensure that the accuracy required, as specified in the QAPP, was met or exceeded.

5. GBA utilized the 16-foot open survey skiff *Sea Scout* for this survey event in order to survey within the shallow depths required.

6. GBA used the survey vessel *Sea Fix* in areas within close proximity to bridges (RM 1.8 to 3.05). The *Sea Fix* is equipped with an inertially-aided positioning system (Applanix – TSS POSMV). This allowed for higher quality horizontal positioning in areas with obstructions to satellite view. The *Sea Fix* is also operating a Odom Mark II single beam transducer and a Leica SmartGPS GX1230+ rover/receiver with a CDMA cellular phone modem for positioning.

4.0 DATA PROCESSING

GBA made all efforts to ensure that the single beam data collected covered the designated shallow areas from -6 feet NGVD29 to 0 feet NGVD29. This was the case the majority of the time, but obstructions and steep shorelines were limiting factors on some of the survey lines.

The initial processing of the single beam data were performed on site to ensure accuracy and that sufficient coverage had been achieved. The single beam data were then transferred to GBA's Houston Office for final processing and QA/QC verification.

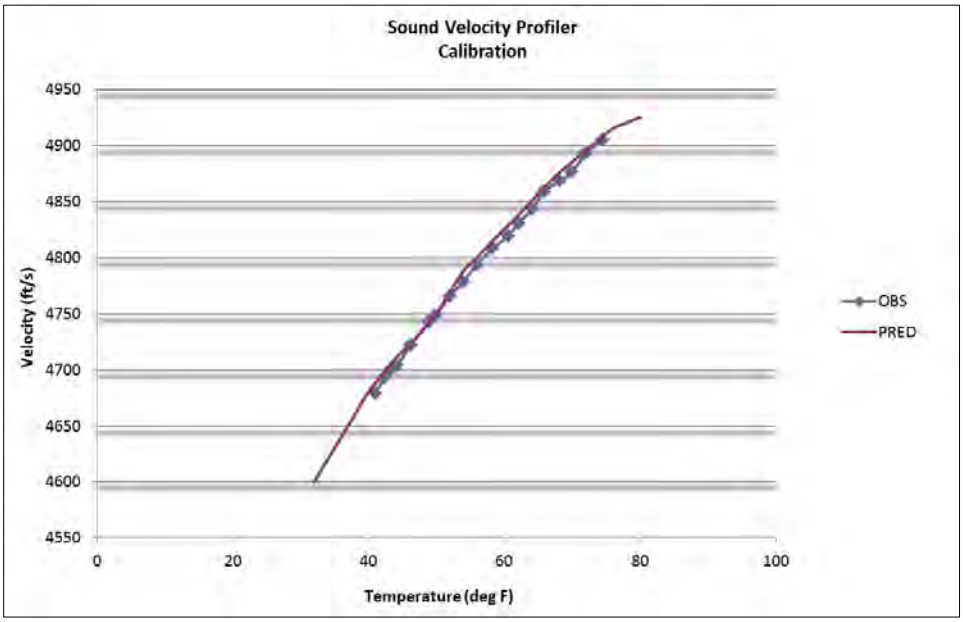
For final processing, data were exported from HYPACK with an averaged 30 second tide. Single beam survey data were processed using GBA's proprietary software (ODP) and erroneous spikes were removed. Final single beam data points were then exported to ASCII XYZ files for the generation of contours at 0.5-foot intervals. Bathymetric maps and cross sections (available upon request) were also produced.

5.0 QUALITY ASSURANCE/QUALITY CONTROL

Throughout the survey, GBA performed several procedures for QA/QC. The sound velocity profiler calibration was performed prior to mobilization. QA/QC checks performed at each survey cycle included two horizontal position checks, two RTK tide checks, periodic sound velocity casts, overlapping survey lines from the previous survey cycle, and latency checks. These procedures including the final QA verification methods are described in the following paragraphs.

Sound Velocity Profiles

The sound velocity profiler calibration was verified as per the method prescribed in the *USACE Engineering and Design Manual - Hydrographic Surveying EM 1110-2-1003* (USACE 2002). The profiler was set in a distilled-water bath using ice to vary the water temperature. Observed sound velocity measurements and water temperature were recorded and plotted against a predicted curve.



Periodically, GBA surveyors performed several velocity casts for transducer calibration. Sound velocity profiles were augmented with numerous bar checks throughout the project.

RTK Corrections

To ensure the accuracy and precision of the Leica SmartNet RTK corrections that were received from the NJIT CORS station, GBA (using a back pack rover) made RTK point observations at both NGS monuments and GBA control points. All checks were within tolerances for RTK GPS of +/- 0.05 ft.

Horizontal Position Checks/ RTK Tide Checks

With the intent of the survey to obtain data from -6.0 feet NGVD29 to 0.0 feet NGVD29, survey activities were limited to two hours on either side of high tide. Checks of the RTK position system were performed by logging the vessel position at the dock at the beginning and end of each survey cycle to ensure no horizontal changes. RTK tides were checked at the beginning and end of each survey cycle by comparing the computed RTK tides to analog tide readings at NUTLEY, PATH 3, and/or the PORT 2 tide board. All RTK tides checks agreed with analog readings within tolerances for RTK GPS of +/- 0.1 ft.

Transducer Calibration/Establishing Acoustic Draft

The physical draft of the single beam transducer was physically measured. The acoustic draft was measured and confirmed via conventional bar check procedures prior

to the commencement of the project, numerous times during the project, and at the end of the single beam survey event.

Final QA Verification

For final QA verification, the overlap/latency lines and perpendicular cross lines were run each day and compared to the data. The single beam data were also compared to 2012 multibeam data where possible as well as to the 2007 and 2011 historical single beam data. Single beam data collected with an overlap to multibeam sounding data agreed within 0.25 feet, well within the standards specified in USACE's *Engineering and Design Manual - Hydrographic Surveying, EM 1110-2-1003* (USACE 2002).

The data were concluded to be satisfactory based on the QA/QC comparison of check lines, multibeam overlap, and historic single beam data.

9.0 DAILY OVERVIEW OF SURVEY OPERATIONS

The following information is representative of GBA's daily surveying activities in reference to the single beam survey of the Passaic River:

Wednesday, 12 September, 2012

- Mobilized from Baltimore, MD to Newark, NJ
- Verified locations of boat ramps and project control

Thursday, 13 September, 2012

- Surveyed RM 9.6 to 10.2
- Surveyed lines 420, 480, 490, 500, 511, 520, and 530 that were previously surveyed by the multibeam vessel to serve as check lines

Friday, 14 September, 2012

- Surveyed RM 9.6 to 10.2

Saturday, 15 September, 2012

- Surveyed RM 9.6 to 10.2
- Surveyed RM 10.5 to 11.2

Sunday, 16 September, 2012

- Surveyed RM 10.5 to 11.2

Monday, 17 September, 2012

- Surveyed RM 6.6 to 7.8

Tuesday, 18 September, 2012

- Surveyed RM 1.8 to 3.05 with the *Sea Fix* which is equipped with a POS MV for positioning around turnpike and railroad bridges where GPS signal would be lost on the *Sea Scout*
- Rain and winds prevented the *Sea Scout* from surveying

Wednesday, 19 September, 2012

- Surveyed RM 6.6 to 7.8

Thursday, 20 September, 2012

- Ran check lines in the vicinity of the CPG dock, no actual survey work performed (note that there are no field logs for this date since there was no survey work conducted)

Friday, 21 September, 2012

- Surveyed RM 1.8 to 3.05

Saturday, 22 September, 2012

- Surveyed RM 6.6 to 7.8 and RM 3.05 to 4.2

Sunday, 23 September, 2012

- Surveyed RM 3.5 to 4.2

Monday, 24 September, 2012

- Surveyed RM 3.5 to 4.2 and RM 1.8 to 3.05

Tuesday, 25 September, 2012

- Surveyed RM 1.8 to 3.05

Wednesday, 26 September, 2012

- Surveyed RM 0.0 to 0.9

Thursday, 27 September, 2012

- Surveyed RM 0.0 to 0.9

Friday, 28 September, 2012

- Surveyed RM 0.0 to 0.9

Saturday, 29 September, 2012

- Surveyed RM 0.0 to 0.9

Sunday, 30 September, 2012

- Demobilized to Baltimore

10.0 CONTACT INFORMATION

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Edward DeAngelo email: edeangelo@gba-inc.com

11.0 REFERENCES

AECOM. 2010. *Quality Assurance Project Plan, Lower Passaic River Restoration Project: Periodic Bathymetric Surveys, Revision 2*.

AECOM, 2012. *Field Modification Number FM-120830-1 for Performance of a Single Beam Survey in Shallow Areas Located Outside the limits of the Multibeam Bathymetry Surveys*. August 30.

Gahagan & Bryant Associates, Inc. 2012. *Periodic Bathymetry Survey, 2012 Report.* Baltimore, MD.

United States Army Corps of Engineers (USACE). 2002. *Engineering and Design Manual - Hydrographic Surveying. EM 1110-2-1003*. Washington, D.C. [Augmented April 1, 2004].

APPENDIX 1

Bathymetry Maps

APPENDIX 2

Copy of Field Notes

APPENDIX 3

Portable Disk including:

Survey Report,
AutoCAD Drawings,
HYPACK Files,
Field Notes,
ASCII Data

Delivered Under Separate Cover

Attachment 3

2012 Periodic Bathymetry and Single Beam Bathymetry Surveys Oversight Report, Lower Passaic River, New Jersey, prepared by AECOM

Prepared for:
Cooperating Parties Group
New Jersey

Prepared by:
AECOM
Seattle, WA
60145884.P222
November 2012

2012 Periodic Bathymetry and Single Beam Bathymetry Surveys Oversight Report

LOWER PASSAIC RIVER, New Jersey

August 29, 2012 – September 29, 2012

Prepared by: William Gerken
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710 Second Ave, Suite 1000
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2012 PERIODIC BATHYMETRY AND SINGLE BEAM SURVEYS

OVERSIGHT REPORT

August 29, 2012 – September 29, 2012

1.0 Project

Lower Passaic River Restoration Project, Bathymetry Survey, AECOM, Project Number 60145884.P222.

2.0 Purpose

The 2012 Periodic Bathymetry and Single Beam Bathymetry Surveys (2012 Periodic Surveys) were conducted by AECOM's contractor, Gahagan & Bryant Associates, Inc. (GBA) between August 29, 2012 and September 29, 2012. Bathymetry surveys are conducted periodically in support of the ongoing Lower Passaic River Study Area (LPRSA) Remedial Investigation / Feasibility Study. The 2012 Periodic Surveys consisted of multibeam and single beam components. The 2012 multibeam survey was performed between August 29, 2012 and September 17, 2012. The 2012 Single Beam Bathymetry Survey was performed between September 13, 2012 and September 29, 2012.

The multibeam component of the periodic survey extended from river mile (RM) 0 to RM 14 of the Lower Passaic River covering the same basic area as the 2007, 2008, 2010, and Fall 2011 bathymetry surveys. In addition (consistent with previous periodic surveys since 2008), single beam survey data were collected at thirteen selected transects. These transects extended from RM 1.6 to RM 8.0.

An additional single beam survey was completed on nine shallow water locations between RM 0.0 and RM 11.2 and Third River. This single beam survey was conducted because the multibeam survey technology and equipment are not suitable for some of the shallower areas in the Lower Passaic River. Target areas for the single beam survey were typically shallower than -6 feet National Geodetic Vertical Datum of 1929 (NGVD29).

Oversight of the survey(s) was provided by AECOM technical staff, and included both on-site observations at survey start-up and daily off-site review of calibration records, survey logs, coverage maps, and progress e-mails. Bill Gerken of AECOM performed primary oversight of the 2012 surveys. He was on site to observe the initial multibeam equipment calibration and the beginning of the periodic survey; he performed off-site oversight activities for the remainder of the survey period. Oversight included review of equipment set up and calibration for consistency with the (United States Army Corps of Engineers) USACE's Engineering and Design Manual - Hydrographic Surveying, EM 1110-2-1003 (USACE, 2002) as well as consistency with previous (2007, 2008, 2010, and 2011) surveys and conformance with the Quality Assurance Project Plan (QAPP) for the Lower Passaic River Restoration Project: Periodic Bathymetric Surveys, Revision 2 (AECOM, 2010); hereafter referred to as the QAPP. Oversight also included ensuring the surveys were performed consistent with the field modifications for this work: 1) Field Modification Number FM-120821-1 for the performance of a periodic bathymetry survey of lower 14 miles of the Passaic River after a period of below average river flows; and 2) Field Modification Number FM-120830-1 for performance of a single beam survey in shallow areas located outside the limits of the multibeam bathymetry surveys. Sea Engineering, Inc. provided oversight on behalf of the United States Environmental Protection Agency (USEPA).

This report (Attachment 3 to the Periodic Bathymetry and Single Beam Bathymetry Surveys, 2012 Report) provides a summary of the bathymetry oversight activities only. GBA's report(s) (Attachments 1 and 2 to the Periodic Bathymetry and Single Beam Bathymetry Surveys, 2012 Report) provides

details of the bathymetry surveys. Processed data files were provided to USEPA under separate cover.

3.0 Survey Location

The multibeam portion of the periodic bathymetry survey extended from RM 0 to RM 14 of the Lower Passaic River covering the same basic area as the 2007, 2008, 2010, and fall 2011 bathymetry surveys. The single beam portion of the periodic bathymetry survey, was conducted at thirteen selected transects, surveyed previously during the 2008, 2010, and fall 2011 survey events. These transects extended from RM 1.6 to RM 8.0. All patch and performance tests were conducted at the same approximate areas as for the previous bathymetry surveys and are described in Section 5.

The 2012 single beam survey was conducted from September 12 to September 29. The single beam survey covered nine shallow water areas located at RM 0 – 0.88, 1.80 – 3.05, 3.50– 4.32, 6.60 – 7.10, 7.10 – 7.50, 7.50 – 7.80, 9.55 – 10.16, 10.55 – 11.00, and 11.20 and Third River.

4.0 GBA Personnel, Equipment and Software

The GBA periodic bathymetry survey team consisted of a Lead Project Surveyor and a two-person crew and included individuals (including the technical lead) that had supported prior LPRSA surveys. The 25-foot GBA survey vessel *Sea Fix* was used for the Periodic Bathymetry Survey, 2012. The equipment used aboard the *Sea Fix*, including equipment for patch and performance tests, and survey operations, was basically the same equipment as that used during the 2011 bathymetry survey(s) by GBA. The equipment on the *Sea Fix* included the Reson 8101 multibeam echosounder, Odem Mark II depth recorder, Leica Real Time Kinematic (RTK) positioning system, Applanix-TSS POSMV, and HYPACK/HYSWEEP data collection/processing software. In addition, a velocity probe was used for sound velocity measurements and a disc type aluminum plate was used for bar check calibrations.

The GBA single beam survey team consisted of a project surveyor and a vessel operator. The 16-foot survey skiff *Sea Scout* was used for the single beam survey effort; data gathered by the Sea Fix was utilized in a select areas in close proximity to bridges. The equipment used aboard the *Sea Scout*, included an Odom CV 100 depth recorder, Leica RTK positioning system, velocity probe and plate type bar check, and HYPACK 2012 data collection software with GBA in-house processing software.

5.0 Process

The survey vessel Sea *Fix* was mobilized to New Jersey on August 28, 2012. The multibeam survey work and single beam survey of the 13 transects were conducted from August 29, 2012 through September 17, 2012. The survey vessel *Sea Scout* was mobilized to New Jersey on September 12, 2012 to perform the single beam survey in the nine shallow areas. The single beam survey of the nine shallow areas was conducted from September 13, 2012 through September 29, 2012. Figures depicting the extents of the survey(s) and reaches referenced in this section are provided in GBA's report(s) (Attachments 1 and 2 to the Periodic Bathymetry and Single Beam Bathymetry Surveys, 2012 Report). GBA's reports also include survey logs and screen images of patch and performance tests.

Oversight included on-site and off-site activities to ensure compliance with the required quality and performance standards identified in the QAPP (AECOM, 2010). These QA/QC activities included multibeam patch and performance tests, horizontal position checks, sound velocity and bar (acoustic depth/transducer calibration) checks, tide level checks, and appropriate survey data coverage. Sea Engineering, Inc. provided oversight on behalf of the USEPA.

All observed work, and work as reported, was performed per the QAPP (as modified by two field modifications: 1) Field Modification Number FM-120821-1 for the performance of a periodic bathymetry survey of lower 14 miles of the Passaic River after a period of below average river flows; and 2) Field Modification Number FM-120830-1 for performance of a single beam survey in shallow areas located outside the limits of the multibeam bathymetry surveys), contract requirements, USACE specifications and acceptable industry standards.

5.1 On-Site Observations

This section describes the oversight activities conducted while AECOM staff (Bill Gerken) was on site to observe the survey activities. Oversight activities included on-site observations and daily off-site review of calibration records, survey logs, coverage maps, and progress e-mails between GBA and AECOM staff. AECOM staff was on site for the multibeam pre-survey patch and performance tests and quality assurance/quality control (QA/QC) procedures, and the first day of multibeam data acquisition, as described below. AECOM field notes are provided in Appendix A. Off-site oversight activities are described in Section 5.2.

August 30, 2012 - Weather conditions: warm, clear and calm, and calm seas.

The *Sea Fix* departed from the Elizabeth City Marina at approximately 0730 and headed for the Newark Bay patch and performance test area, stopping at the Port Elizabeth dock to perform a velocity cast/check and bar check. On the vessel were Bill Gerken (AECOM), Ed DeAngelo (GBA), Travis Schmidt (GBA), Mathew Joyce (GBA), and Jason Magalen (Sea Engineering, Inc.).

A multibeam system patch test was performed on the *Sea Fix* in Newark Bay. This test consisted of a series of survey lines run to reveal and then correct for any system biases in roll, pitch, and yaw.

A performance test (beam angle test and single beam-multibeam comparison test) was conducted in Newark Bay. Separate multibeam and single beam surveys were run and the overlapping data were compared to evaluate the multibeam data quality. This check provided a statistical estimate of the data accuracy. The quality control calibration and performance tests were processed and adjusted aboard the survey vessel prior to any multibeam data collection. After the performance test, the *Sea Fix* proceeded to control point PORT 2 where the crew repaired the tide staff and verified vertical control/system tide adjustment.

The survey vessel then proceeded to the RM 2.5 Reach B01 survey area. Reaches B01 and B02 (RM 2.5 – 3.1) were surveyed and single beam survey check lines were performed on Reach B01. Sound velocity casts, bar checks, and tide checks were performed.

5.2 Off-Site Oversight Activities

For all survey days where AECOM staff were not on site, Bill Gerken of AECOM was available by phone and e-mail to address questions and/or concerns. Each day, he received daily field logs, coverage maps, e-mail progress updates, and any additional tests or QA/QC data for review. Bill Gerken reviewed this information to ensure the survey was meeting the requirements set forth in the QAPP. The only noted deviations from the QAPP were very minor and are described below.

6.0 Deviations from the QAPP

The following represent minor deviations from the QAPP (AECOM, 2010). These deviations did not impact achievement of the data quality objectives developed for this bathymetry survey.

- Ongoing construction at the Lister Avenue Site blocked full coverage up to the -6-foot NGVD29 contour and/or to the bulkhead for 500± feet.

- Ongoing construction on the Newark side of B06 downriver from the Jackson Street Bridge blocked full coverage up to the -6-foot NGVD29 contour due to a boom that has been put in place. The area impacted extends from RM 4.15 to the Jackson St. Bridge (RM 4.37).

In addition, there were minor areas along the shore where full coverage up to the -6-foot NGVD29 contour could not be achieved because of trees overhanging the river, and obstructions along the shoreline.

7.0 Results

All calibration data were collected in conformance with the criteria specified in the QAPP (AECOM, 2010). The results of the pre-survey, mid-survey, and post-survey multibeam performance tests are given below in Table 1; all results are consistent with the USACE's Engineering and Design Manual - Hydrographic Surveying, EM 1110-2-1003 (USACE, 2002). The maximum allowable bias (mean difference) is a measure of the difference between the multibeam survey and the single beam survey run over the same location. Single beam check lines performed daily validated accuracy/repeatability of the multibeam work completed. The pre-survey, mid-survey, and post-survey results compare favorably with applicable soft bottom standards presented in the USACE's Engineering and Design Manual - Hydrographic Surveying, EM 1110-2-1003 (USACE, 2002).

Table 1 Minimum Quality and Performance Standards for Multibeam Hydrographic Surveys

	Standards[1]	Pre-Survey Results (August 30, 2012)	Mid-Survey Results (September 11, 2012)	Post-Survey Results (September 17, 2012)
Maximum outliers between data set comparison points	1 ft	0.59 ft	0.51 ft	0.88 ft
Maximum allowable bias	± 0.2 ft	0.03 ft	0.01 ft	-0.08 ft
Resultant elevation/depth accuracy (95%) (acoustic survey at depth > 40 ft)	± 2.0 ft	0.19 ft	0.20 ft	0.45 ft

[1] Navigation & Dredging Surveys Bottom Material Classification - Soft (from USACE's Engineering and Design - Hydrographic Surveying, EM 1110-2-1003, Chapter 3, Table 3.1 and Chapter 11, Table 11.2 [USACE, 2002])

Horizontal position checks were performed at the beginning and end of the day to reveal any potential positioning errors. The differences in position for each of the multibeam and single beam surveys were within industry standards and contract specifications.

Single beam bar checks were performed within the project area as a method of calibration for acoustic depth measurements and adjustments that needed to be made to subsequent recorded depths. Bar checks were performed, at a minimum, before and after each single beam survey event, checks were made at multiple depth intervals. A multibeam bar check was conducted in Baltimore, MD prior to mobilizing and again when the vessel was on site in New Jersey.

Sound velocity profiles were also collected using a velocity probe to measure changes in the water column that affect data quality such as temperature and salinity. Velocity profiles were taken in the work area at the beginning of data collection on each reach and/or sub-reach, and the start of each day.

8.0 Conclusion

The survey equipment and calibration, and survey procedures used by GBA during the 2012 Periodic Bathymetry Survey (multibeam and single beam surveys) and the 2012 Single Beam Bathymetry Survey conform to the applicable accuracy standards and quality control and quality assurance requirements specified in the QAPP, contract requirements, USACE specifications, and acceptable industry standards.

9.0 Contact

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10.0 References

AECOM, 2010. Quality Assurance Project Plan, Lower Passaic River Restoration Project: Periodic Bathymetric Surveys, Revision 2.

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Appendix A

AECOM Field Notes